NASA-CR-54392

TWO STAGE POTASSIUM TEST TURBINE

QUARTERLY PROGRESS REPORT NO. 15

Period : November 8, 1964 Thru February 8, 1965

EDITED BY E. SCHNETZER

prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONTRACT NAS 5-1143

SPACE POWER AND PROPULSION SECTION

MISSILE AND SPACE DIVISION

GENERAL ELECTRIC

CINCINNATI, OHIO 45215

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Edited By
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Contract NAS 5-1143

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ABSTRACT

The General Electric Company is investigating a two-stage potassium vapor turbine under Contract NAS 5-1143.

During the quarter ending February 8, 1965, the turbine was first inspected in place, then removed from the test facility, disassembled and thoroughly inspected. Repair and hardware changes have been carried out to prepare the turbine for performance testing in March, 1965.

The performance test results obtained in the September-October testing have been further analyzed and evaluated. The results have been compared to predicted turbine performance. The accuracy of measurements has been critically investigated. Steps have been taken to improve the accuracy of flow and torque measurements. Improved instrumentation is being provided to monitor the boiler and its stability behavior.

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LIST OF SYMBOLS

SYMBOLS	
A	effective flow area, in^2
C_{pk}	specific heat of liquid potassium, Btu/lb °R
C_{pl}	specific heat of lube oil, Btu/lb °R
g	gravitational constant, 32.2 ft/sec^2
Δh	stage work, Btu/lb
$\Delta h'$	ideal enthalpy change, Btu/lb
Δh_d	enthalpy loss due to droplet drag, Btu/lb
Δh_{is}	total to static isentropic enthalpy drop
J	Joule's constant, 778 ft lb/Btu
K	constant
N	rotative speed, rpm
n	exponent of N or polytropic exponent
P	pressure, psia
P_f	facility pressure, psia
Q	torque, in-lb
R_x	reaction, defined by equation (10)
T	temperature, °F
ΔT	temperature rise, °F
U_p	rotor pitch line speed, ft/sec
V	velocity, ft/sec
v	specific volume, ft^3/lb
W	mass flow rate, lb/sec
ρ	density, lb/ft^3
X	quality
η_t	turbine efficiency
γ	polytropic exponent

SUBSCRIPTS

a or act	actual
bb	ball bearing
bs	water brake bearings and seals
bw	blade windage
c	corrected parameter
d	digital readout
dw	disk windage
ex	exit
hs	hydrodynamic seal
in	inlet
k	potassium
kb	potassium turbine bearings
m	manual readout
n	nozzle
pb	pad bearing
qk	potassium flow
qw	water brake seal flow
ref	reference
s	steam turbine or static
sat	saturated vapor
T	total
t	turbine
tt	tare torque
w	water brake seal flow
x	axial
3	turbine inlet station
1	first stage
2	second stage

I. SUMMARY

The Re-Entry Systems Department of the General Electric Company has been under contract to the National Aeronautics and Space Administration since May 8, 1961, for the design and fabrication of a two-stage test turbine suitable for operation in saturated potassium vapor at 1600°F. The test turbine consists of stages three and four of a five-stage 500 KW turbine and is to have a design flow capacity of 2.8 pounds per second. The present phase of the contract covers assembly, test, and evaluation of the turbine and associated components.

The main objectives of this program are to study the effects of vapor wetness on performance, to study impingement damage and washing erosion with different blade materials, to study the phenomena of supersaturation and droplet formation, to establish the values of the polytropic exponent of potassium vapor as an improvement over General Electric's calculated Mollier diagrams, and finally, to establish accurate fluid flow design methods for potassium turbines operating in the wet vapor region. The test turbine runs on oil lubricated bearings. The test program anticipates 200 hours of performance testing and two 1,000 hours endurance tests.

The present report covers progress during the quarter ending February 8, 1965.

The main events for this reporting period are:

The turbine has been inspected in place by opening its welded front flange. It was then removed from the test facility, disassembled, inspected and rebuilt in preparation of performance tests in March, 1965.

During testing in September-October, 1964, the turbine operated on potassium vapor for 40 hours at inlet temperatures ranging from 1400 to 1580°F. Of the 126 total performance test points, as specified in reference (1), 103 were obtained. During this test, the mechanical systems of the turbine performed well, however, testing was accompanied by instabilities of the boiler creating speed variations and speed surges of the turbo-machinery. Testing was interrupted different times by potassium leaks of instrumentation lines resulting in fire damage. Testing was ultimately terminated by a leak in the upper boiler drum requiring shut-down for repair and permitting inspection of the turbine.

Turbine inspection revealed two major damage areas: excessive erosion of the first turbine stage and fire damage on the second stage stator vanes and tip seals. Inspection and analysis indicated that the fire damage to the stator vanes and casing tip seals had occurred on October 4, 1964, when an instrumentation pressure tap weld had failed, allowing air to be drawn into the turbine casing, which was at below atmospheric pressure. The heavy erosion of the first turbine stage was attributed to the following: 1. The operation of a potassium liquid spray nozzle upstream of the turbine to

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(1) "Test Plan - Two Stage Turbine Test in Potassium, Revision No. 1" April 20, 1964, Table V.

change vapor quality, 2. The one to two percent vapor wetness recorded by the throttling calorimeter upstream of the turbine which determines boiler exit flow quality. Gross potassium carry-over from the boiler could not be verified by measurements. The next testing will be done without injection spray and after a corresponding 40 hours of vapor operation, the turbine will be re-opened for inspection and comparison.

The turbine has been rebuilt with extensive use of second hardware. Turbine rotor, potassium to oil seal, turbine inter-stage and turbine tip seals are new. The nozzle diaphragms were repaired. Design changes were only applied where essential, such as to blade retaining clips, which were made heavier because some of them were broken during previous testing. Changed also was the cover of the tube cavity of the turbine bearing housing. It is now equipped with a bellows to better withstand differential thermal expansion.

The turbine is presently being assembled and re-installed in the test facility for further performance testing.

The performance test results obtained in the September-October testing have been further analyzed and evaluated. Data evaluation was difficult because the data taken in general were not within the error margins intended. It also was evident that the data were taken with various damage on the turbine, so that the final results were not entirely consistent. In investigating the accuracy obtained in measuring flow and torque, the two basic measurements in obtaining performance, it became apparent that either one showed a considerable error margin resulting from instrumentation and methods used. The error analysis indicated ways of improving both measurements. The vapor velocity measurement for the bullet nose will be used in future testing as the prime method of establishing flow. To improve the torque measuring system, the Bytrex torque meters have been recalibrated and the tare losses of the turbine, consisting of bearing, seal and residual water brake losses, have been carefully re-established.

In evaluating performance data, the damage caused by the fire on October 4 could be clearly identified. The factors impairing turbine efficiency have been established in detail. It is concluded that the performance test should be repeated with the turbine repaired and the test facility improved in regard to its stability behavior.

The test facility modifications are about 80 per cent complete. They include:

- repair welding of the upper boiler drum ends
- changes of the boiler feed system, including feed preheat
- floating suspension of the upper boiler drum ends
- installation of electrical heaters on the upper boiler drum
- improved instrumentation to monitor boiler temperature, pressure, and liquid level
- installation of a moisture separator at vapor outlet
- improved condenser temperature control to permit higher temperature condensate
- larger filters for argon extraction and reclamation system.

Material support established dump tank potassium analyses for carbon which disclosed erratic levels. These appear to be the result of particulate carbon suspended in the potassium. The oxygen content of the potassium increased after the occurrence of leaks in the system but was readily lowered to a level believed safe for further operation by hot trapping at 1100°F.

Metallography and microhardness evaluation of first stage buckets support the hypothesis that metal was removed only at the liquid metal interface; no diffusion or subsurface effects were noted.

FORECAST AND SCHEDULE

Preparations for the resumption of testing will be completed. Flow and torque measurements will be strongly improved and it is anticipated that it will be possible to hold turbine speed within ±250 rpm during data taking. A revised test plan will be established as a basis for a second performance test. It is hoped that the second performance test will be completed within the coming quarter. Efforts continue to establish a complete set of second hardware with latest deliveries in August, 1965.

II. FLUID DYNAMIC TESTING

During the reporting period, the predicted turbine off-design performance data was obtained and potassium turbine performance was compared with this data. Preparations were also made for the next performance test.

A. PREDICTED TURBINE OFF-DESIGN PERFORMANCE

1. Methods

The turbine predicted off-design performance data was obtained using Naval Research Laboratories (NRL) potassium properties.(2) In order to obtain predicted performance for the two-stage potassium turbine, an available combustion-gas-turbine off-design computer program (TOD) was utilized after suitable modification for two-phase vapor flow. It was assumed that supersaturated flow conditions existed throughout each stage with reversion occurring at each stage exit.(3) Off-design incidence-angle loss factors were determined assuming that only the component of the blade approach velocity parallel to the design approach direction was effective and the rest was lost. Bucket and nozzle exit flow deviation angle for each stage for all off-design cases did not vary but rather remained equal to the design values. It was further assumed that pitchline property and parameter values were representative of the average across the annulus area.(4)

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(2) E. Schnetzer: Two Stage Potassium Test Turbine, Quarterly Progress Report No. 14. Contract NAS 5-1143, NASA - CR 54285, November 8, 1964, Appendix.

(3) R. J. Rossbach: Critical Flow of Potassium Vapor Through Instrumented Converging-Delivery Nozzle. A.S.M.E. Preprint 65-GTP-22, March 1, 1965.

(4) R. H. Cavicchi and R. E. English: A Rapid Method for Use in Design of Turbines Within Specified Aerodynamic Limits. NACA TN 2905, April, 1953.

In order to use TOD, certain turbine fixed data input were required for all test points as shown in Table I. Stage inlet polytropic exponent, n, was determined from each stage inlet condition of total temperature and vapor quality, x, using the relationship

$$n = n_{sat} - 1.13\ (1 - x) \tag{1}$$

where n_{sat} is the saturated polytropic exponent[(2)] computed from the NRL properties and 1.13 is the experimental constant derived from the convergent-divergent potassium nozzle tests. The gas constant which is also required as fixed input for each case is derived from the perfect gas law using turbine inlet conditions of total temperature and pressure and specific volume. Actual hardware dimensions such as hub and pitchline diameters were included. Inspection reports were used to obtain actual bucket angles and flow areas. From the nozzle blow test[(5)] data, effective flow area for each nozzle diaphragm was determined. The nozzle flow coefficients were set equal to 1.0 and the nozzle exit angles were adjusted so as to result in the effective flow area found during the blow tests of the diaphragms. This changes the stage nozzle design exit angles from 74.5° to 71.25° and 72.5° to 72.2° for the first and second stage nozzles, respectively.

An existing turbine efficiency program (TEP) was used to estimate the level of predicted performance of the test turbine at approximately design conditions, namely, 19,200 rpm, 1600°F, 92 percent inlet vapor

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[(2)] E. Schnetzer: Two Stage Potassium Test Turbine, Quarterly Progress Report No. 14. Contract NAS 5-1143, NASA - CR54285, November 8, 1964, Appendix.

[(5)] E. Schnetzer: Two Stage Potassium Test Turbine, Quarterly Progress Report No. 11. Contract NAS 5-1143, February 8, 1964, page 79.

quality and a total-to-total pressure ratio of 2.95. The TEP calculates turbine efficiency based on loss factors for the stationary and rotating blade rows.[6] These loss factors take into account profile losses, secondary flow losses, tip clearance losses, aspect ratio, blade thickness and Reynolds number effects. The results of the TEP were used to determine the values of zero-incidence nozzle and bucket efficiencies for each stage to be used in TOD.

Shown in Table II is a comparison of the results of the TEP and TOD programs at approximately design conditions. The TEP is a design program which calculates the turbine geometry and loss factors for given flow and work requirements. The TOD program calculates the flow and work that would be obtained with a given geometry and loss factors. Therefore, an iterative procedure is required for exact matching of the results of the two programs.

It can be seen in Table II that the flow velocities and flow angles agree very well between the results of the two programs. The overall turbine total-to-total efficiency agrees within 1.5 percentage points between the two methods. The slight difference is attributed to differences in calculation procedures and in loss factors between the final runs of these programs.

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(6) The TEP is based upon "An Examination of the Flow and Pressure Losses in Blade Hours of Axial-Flow Turbines", by D.G. Ainley and G.C.R. Mathieson, NGTE Reports and Memoranda No. 2891, 1951.

The results of TOD were used as input for the Turbine Performance Parameter (TPP) digital computer program to obtain predicted values of turbine efficiency, turbine work and the corrected performance parameters. In the TPP program, turbine work is corrected for droplet drag losses which are determined by assuming that the moisture entering each stage must be accelerated to pitchline wheel speed upon entering the rotor. Turbine efficiency is then calculated using the values of flow and specific work output (after the droplet drag loss correction) for each stage. The ideal power is based on the total turbine flow and the isentropic enthalpy drop from the NRL wet properties[(2)].

The calculation procedure used to determine droplet drag losses, turbine actual specific work output and turbine efficiency are as follows:

$$\Delta h_d = \frac{(1-X_1)\; U_{P1}^{\;2}}{g\,J} + \frac{(1-X_2)\; U_{P2}^{\;3}}{g\,J} \tag{2}$$

$$\Delta h_a = X_1\, \Delta h_1 + X_2\, \Delta h_2 - \Delta h_d \tag{3}$$

$$\eta_t = \frac{\Delta h_a}{\Delta h'} \tag{4}$$

See List of Symbols for nomenclature.

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(2) E. Schnetzer: Two Stage Potassium Test Turbine, Quarterly Progress Report No. 14. Contract NAS 5-1143, NASA - CR54285, November 8, 1964, Appendix.

The corrected parameters, namely, speed, specific work, flow and power are calculated and referenced to design inlet conditions, namely, 1600°F and 92 per cent vapor quality inlet conditions. These parameters are defined as follows:

Flow parameter:
$$W_c = W_t \frac{\left[\left(\frac{\gamma+1}{2}\right)^{\frac{\gamma+1}{\gamma-1}}\left(v_T/P_T\,\gamma\right)\right]^{1/2}_{act}}{\left[\left(\frac{\gamma+1}{2}\right)^{\frac{\gamma+1}{\gamma-1}}\left(v_T/P_T\,\gamma\right)\right]^{1/2}_{ref}} \tag{5}$$

Speed parameter:
$$N_c = N \frac{\left[\left(\frac{\gamma+1}{\gamma}\right)/\left(P_T\,v_T\right)\right]^{1/2}_{act}}{\left[\left(\frac{\gamma+1}{\gamma}\right)/\left(P_T\,v_T\right)\right]^{1/2}_{ref}} \tag{6}$$

Specific work parameter:
$$\Delta h_c = \frac{\Delta h_{act}\left[\left(\frac{\gamma+1}{\gamma}\right)/\left(P_T\,v_T\right)\right]_{act}}{\left[\left(\frac{\gamma+1}{\gamma}\right)/\left(P_T\,v_T\right)\right]_{ref}} \tag{7}$$

Horsepower parameter:
$$HP_c = 1.415\,\Delta h_c\,W_c \tag{8}$$

Kilowatt parameter:
$$KW_c = 1.0555\,\Delta h_c\,W_c \tag{9}$$

2. Estimated Turbine Performance Losses

Effect of Tip Clearance Loss and Other Losses on Design-Point Efficiency

Shown in Figure 2 is the effect of tip clearance losses and other losses on the two-stage turbine total-to-total design-point efficiency. The design inlet temperature and vapor quality are 1600°F and 92 per cent, respectively. The design pressure ratio and speed are 2.95 and 19,200 rpm, respectively. At zero tip clearance, the efficiency based upon supersaturated flow is 88 per cent. Included in the losses at this condition are the velocity diagram losses, blade profile losses and the secondary flow loss. As the tip clearance increases, the efficiency decreases due to the increased losses in the tip region. At 25 mils radial clearance, the tip-clearance loss is about half of the total loss across the rotor. At 50 mils, this loss increases to about two-thirds of the rotor loss. The methods for estimating the profile, secondary flow, and tip clearance losses are those of Ainley and Mathieson.

The design-point performance of the two-stage turbine in potassium vapor was estimated at a running or hot clearance of 50 mils. At this point, under supersaturated conditions, the efficiency was estimated to be 79.3 per cent as shown by the upper most curve. When the ideal work is calculated from the potassium Mollier diagram at the same inlet conditions and pressure ratio, the efficiency decreases to 74.7 per cent, as shown by the middle curve. When the losses due to accelerating the liquid present to rotor speed, the efficiency becomes 70.5 per cent as shown by the lower most curve.

Profile losses can be reduced by making lighter loaded stages, i.e., lower ratio of specific work to the square of the blade speed. The supersaturation loss cannot be easily controlled. The loss due to the presence of moisture can be reduced by moisture extraction or the use of some superheat. In addition to reducing tip clearance, the tip clearance loss can be reduced by using rotating tip shrouds, at the cost of higher blade and disk stresses, The shrouds permit reducing the effective clearance between rotor and casing and reduce the deleterious effect of the interaction of clearance flow with the main stream.[7]

3. Off-Design Data

In Figure 3, the turbine predicted off-design performance for 1600°F and 99 and 92 per cent vapor quality inlet conditions is presented for approximately 100 per cent design corrected speed. At design conditions, namely, 92 per cent inlet vapor quality and inlet total to exit total pressure ratio of 2.95, the total to total efficiency is 70.5 per cent, which is 4.5 percentage points lower than for respective conditions at 99 per cent inlet vapor quality, which compares closely to boiler exit vapor quality as determined by use of the throttling calorimeter.

The corrected power decreases by four kilowatts and the specific work decreases by seven Btu/lb_m as inlet vapor quality decreases from 99 to 92 per cent.

The interstage static pressure to inlet total pressure variation, for design conditions of 1600°F inlet temperature, and 92 per cent vapor quality and 19,200 rpm is presented in Figure 4. Choking at the first stage nozzle and bucket exit and the second stage nozzle occur at approximately 3.25 inlet to exit total pressure ratio.

The stage work split for design point conditions, shown in Figure 5, illustrates that at the low pressure ratios, most of the turbine work is

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[7] H. R. Cox: Gas Turbines Principles and Practice. D. Von Nostrand Co., Inc., New York, 1955, p. 8-28.

obtained in the first stage and, as the turbine overall pressure ratio increases, the second stage begins to do a larger proportion of the total work. In Figure 6, the first and second stage hub reaction is presented.

The reaction is given by $R_x = 1 - \frac{\left(\Delta h_{is}\right)_n}{\left(\Delta h_{is}\right)_t}$. (10)

The first stage hub reaction tends to peak and essentially remain constant at a pressure ratio of 2.0. However, the second stage hub reaction continually increases as pressure ratio increases. This is compatible with Figure 4, which illustrates the continually decreasing of turbine exit static pressure which second stage hub reaction is a function of.

In Figure 7, the predicted turbine off-design performance data for 1550°F and 99 per cent vapor quality inlet conditions is shown as a function of total pressure ratio and for various corrected speeds. The corrected specific work and power parameters tend to increase with increasing total to total pressure ratio and turbine speed as is the case for most turbines. The corrected flow for all corrected speed conditions begins choking at a total to total pressure ratio of approximately 2.8 and the level of choked flow decreases as the turbine speed increases. Turbine total to total efficiency peaks, between 1.60 and 2.20 pressure ratio, depending upon the speed, and then continues to decrease with increasing pressure ratio. Efficiency tends to be higher for lower speeds up to a pressure ratio of 2.20, after which, the efficiency increases as turbine speed in increased. Efficiency peaks at lower pressure ratios for the lower speeds and shifts to higher pressure ratio as speed is increased.

In Figure 8, the predicted off-design data for a turbine inlet temperature of 1550°F and inlet vapor qualities of 99, 95, 92 and 85 per cent are presented. For a constant design corrected speed of approximately 19,200 rpm, the efficiency decreases by approximately 1.5, 1.5 and 3.0 per cent at a pressure ratio of 3.0 for inlet vapor quality levels of 99 to 95, 95 to 92 and 92 to 85 per cent, respectively. The power level decrease for the same respective inlet vapor quality change is approximately -1, -1 and 0 kilowatts for corresponding total to static pressure ratio values. The corrected specific work level decrease from 99 to 85 per cent vapor quality is approximately 12 Btu/lb_m.

The predicted turbine off-design performance data for an inlet temperature of 1450°F and 99 per cent inlet vapor quality are shown in Figure 9 as a function of total to total pressure ratio and for various corrected speeds. The efficiency peaks between pressure ratios of 1.60 and 2.20 and then continues to decrease with increasing pressure ratio in a similar manner to the data for 1550°F and 99 per cent inlet vapor quality. Efficiency tends to be higher for lower speeds to a pressure ratio of 2.20, after which, efficiency increases as turbine speed is increased. Efficiency peaks at lower pressure ratios for lower speeds and shifts to higher speed as speed increases.

In Figure 10, the turbine off-design predicted performance data for an inlet temperature of 1450°F and values of inlet vapor qualities of 99, 95, 92 and 85 per cent are presented for various corrected speeds. The corrected specific work and power increase continuously for increasing total to total pressure ratio and turbine speed. The corrected flow parameter peaks at a pressure ratio of about 2.9 and the choked level decreases as turbine speed is increased. The changes in corrected power due to quality changes are approximately 2, 2 and 1 kilowatts for respective changes in inlet vapor quality from 99 to 95 per cent, 95 to 92 per cent, and 92 to 85 per cent. The corrected specific work decreases approximately 12 Btu/lb_m for the 99 to 85 per cent inlet vapor quality change. The efficiency levels change in the same manner as was true for 1450°F temperature conditions, and the efficiency values are approximately the same for a given corrected speed and total to total pressure ratio.

4. Two-Stage Turbine Estimated Torque and Flow Data

In Figure 11, the potassium dry vapor flow variations for temperature values of 1600, 1550 and 1450°F are presented for various turbine rotative speeds and inlet to exit total pressure ratios. For these figures, the vapor inlet quality is 99 per cent. Flow increases as temperature level is increased because the saturated value of inlet specific volume decreases. For a given inlet temperature level, the flow level is higher for lower turbine speeds. In all cases, choking occurs at a pressure ratio of approximately 3.0.

In Figure 12, the potassium dry vapor flow variations with inlet vapor quality are presented as a function of total to total pressure ratio for inlet temperatures of 1600, 1550 and 1450°F. For temperatures of 1550 and 1450°F, the quality range is 99 to 85 per cent while for 1600°F, the range is 99 to 92 per cent. The data is presented for approximately design corrected speed, namely, 19,200 rpm in all cases, which results in different actual speeds for each temperature. At each inlet temperature condition, the dry vapor flow level decreases slightly as inlet vapor quality is reduced. The dry vapor flow divided by the experimental boiler exit quality (not necessarily 99 per cent) gives an estimate of the flow that should be read on the main electromagnetic flowmeter.

In Figure 13, the turbine blading torque variation is presented for inlet temperatures of 1600, 1550 and 1450°F, as a function of turbine total to total pressure ratio and rotative speed. This data is for an inlet vapor quality of 99 per cent. The blading torque consists of turbine shaft torque plus turbine bearing and seal losses. At a given pressure ratio and speed, the torque values increase with inlet temperature because the turbine flow increases with temperature.

In Figure 14, the turbine net blading torque variation with inlet vapor quality and pressure ratio is presented for inlet temperatures of 1600, 1550, and 1450°F. For these figures, approximately design corrected speed was used, resulting in the actual speeds shown. In all cases, the torque level decreases slightly as inlet vapor quality decreases, due to increasing droplet drag losses.

B. TURBINE TEST RESULTS

1. Measurements

a. Instrumentation

Performance instrumentation was located at four stations[8]. Station No. 1 is upstream of the turbine and measures conditions before the liquid is injected into the stream. Station No. 3 is in the annulus formed by the inlet duct and the turbine bullet nose. Station No. 7 is in the turbine exit annulus and Station No. 8 is downstream of the turbine but ahead of the condenser. Pressure and temperature measurements were recorded through

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[8] E. Schnetzer: Two-Stage Potassium Test Turbine, Quarterly Report No. 11. Contract NAS 5-1143, February 8, 1964, Figures 23 and 24.

the digital readout system. The several values at each station were averaged in the data reduction program for use in the calculation of turbine performance.

Only pressure measurements are used to calculate ideal enthalpy change and efficiency. Temperature measurements are used to calculate the value of polytropic exponent used for corrected parameters. A comparison of static pressures with vapor pressures corresponding to measured temperatures is made in Reference (9). Pressure measurements affect the turbine efficiency calculation because the measured pressures are used to calculate the ideal enthalpy change which is the basis for turbine efficiency. For instance, an expansion from 20 to 7 psia has an ideal enthalpy change of 84 Btu/lb from the potassium Mollier diagram. If the inlet pressure measurement was 19 psia, the calculated ideal enthalpy change would be 80 Btu/lb, resulting in an error of 5 per cent in turbine efficiency. Similarly, a 1 psi error in exit pressure would result in a 10 per cent error in ideal enthalpy change and efficiency. Thus, the calculated efficiency is very sensitive to pressure measurement, particularly at the turbine exit.

The quality of the vapor as it leaves the boiler is determined by means of throttling a sample of the boiler outlet flow. By throttling into the superheat region, an enthalpy can be determined as a function of temperature and pressure. This enthalpy and the initial pressure define the quality of the vapor coming from the boiler. The turbine inlet quality is calculated from an energy balance using the inlet vapor and the liquid spray flow. The accuracy of quality measurement depends upon getting a good sample.

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(9) E. Schnetzer: Two-Stage Potassium Test Turbine, Quarterly Report No. 14. Contract NAS 5-1143, NASA - CR 54285, November 8, 1964.

Checks made on data from the C-D nozzle tests show good correlation between the quality of the sample flow and the total flow with a maximum error of 0.7 per cent. (See Figure 15.)

Rotative speed was measured using a magnetic pickup and a Berkley counter for visual observation. The speed signal was recorded on five digital channels and these values were averaged in the data reduction program. Because of a restriction in the number of times the amplification can be changed during a digital scan, these five channels were adjacent to each other and readout sequentially at about the middle of the entire digital scan. Several methods are being examined to improve the readout of speed measurement for future testing.

b. Torque

The experimental efficiency of the turbine involves the following measurements: inlet vapor total pressure and quality, exit total pressure, vapor flow, liquid spray flow, rotative speed, main torque meter reading and steam turbine torque meter reading. The turbine efficiency is the ratio of measured power output to the theoretical power output.

Since the efficiency of a turbine is proportional to the torque developed, the accurate determination of torque during performance testing is requisite to the calculation of the experimental efficiency. Since the bearings and seals utilized for the two-stage turbine have substantially different power absorption characteristics than bearings and seals that would be used in the space-type turbine, and because the program is oriented toward establishing turbine fluid design procedures, it is necessary to add the torque absorbed by the hydrodynamic seal and the oil lubricated bearings to the measured turbine torque to obtain the torque actually produced by the turbine blading.

Shown in Figure 16 is the installation drawing for the two-stage turbine showing in addition the water brake, the steam turbine, and two Bytrex torque meters. The larger of the two torque meters (Model No. PT-1250, full scale 2500 in.lb.) connects the frames of the two-stage turbine and the water brake. The smaller of the two torque meters (Model No. 200, full scale 200 in.lb.) connects the frame of the steam turbine to the frame of the two-stage turbine by means of the enclosing shell. The reading of the larger torque meter, herein called the potassium-turbine torque meter, Q'_{kd}, consists of the following torque increments during performance testing.

$$Q'_{kd} = Q_{kt} - Q_{hs} - Q_{kb} + Q_{st} \tag{11}$$

while the smaller torque meter, called the steam turbine torque meter, Q_{st}, measures the torque put into the test turbine shaft by the steam turbine, or

$$Q'_{sd} = Q_{st} \tag{12}$$

The value of torque sought for efficiency determination is the two-stage turbine blading torque, Q_{kt}. The hydrodynamic seal torque, Q_{hs}, and the two-stage turbine bearing torque, Q_{kb}, are determined during tare testing.

$$Q_{kt} = Q'_{kd} - Q'_{sd} + Q_{hs} + Q_{kb} \tag{13}$$

For tare testing,

$$Q_{kd} = Q_{st} - Q_{hs} - Q_{kb} - Q_{bw} \tag{14}$$

This is the same as (11) except that the turbine blading torque is negative and is called blade windage. This blade windage comes about during tare test by having to drive the two-stage turbine by means of the steam turbine with a finite pressure of the argon cover gas in the test facility. During tare testing, the blade windage torque, Q_{bw}, is minimized by evacuating the facility to a pressure level in the order of two psia.

Solve for $Q_{hs} + Q_{kb}$ from (14) and substitute in (13)

$$Q_{kt} = (Q'_{kd} - Q'_{sd}) + (Q_{sd} - Q_{kd}) - Q_{bw} \tag{15}$$

In Equation (15), the primed quantities relate to performance testing and the unprimed quantities relate to tare testing. The blading torque of the turbine can be seen to be the sum of the differences of the readings of the two torque meters minus the torque due to the turbine blade windage.

Presented in Table III are the tare test data obtained on several test dates between April and December of the past year. The most comprehensive data was obtained on April 11, 1964, but most of this data was taken at substantial facility pressures, resulting in too large values of blade windage torque. The data of October 2, 1964, on the other hand, is quite limited, but was taken during the performance testing period with the digital data handling system and is believed to represent quite well the tare torque of the hardware buildup for actual performance testing. Therefore, in order to facilitate data reduction, the data for April 11, 1964 and October 2, 1964 were combined to obtain a timely estimate of tare torque.

The results are shown in Figure 17. On logarithm paper, the tare torque of April 11, 1964 from Figure 25, which is found in Reference (10), for a facility pressure of 18 psia was plotted against rotative speed. The data for October 2, 1964 for a facility pressure of about 3.0 psia is also plotted. The tare torque estimate is then the line through the October 2, 1964 data parallel to the line through the April 11, 1964 data.

While data reduction using the above tare torque estimate was being carried out, a more detailed analysis of tare test data was initiated.

Typical of the tare torque data shown in Table III are the following excerpts:

Test Date	Rotative Speed, rpm	Facility Pressure, psia	Tare Torque, in-lbs.
9/28/64	16,133	2.39	37.8
10/2/64	16,106	2.94	80.0
Difference	27	-.55	-42.2

From the above table, it is apparent that for two different test days, the tare torque differed by a little more than 42 in-lbs. at approximately the same rotative speed and facility pressure.

During performance testing, for example, at 1450°F, the following set of torque readings is typical:

Q'_{kd}, in-lbs	432
Q'_{sd}, in-lbs	101
Q_{sd}, in-lbs	150
Q_{kd}, in-lbs	52
Q_{kt}, in-lbs	435

(10) E. Schnetzer: Two-Stage Potassium Test Turbine, Quarterly Report No. 12. Contract NAS 5-1143, May 8, 1964.

If the value of tare torque from above is compared with the final value in the table of typical torque values, it is seen that these 42 in-lbs of torque amount to approximately 10 per cent of the gross torque of the test turbine. This means that there would be an uncertainty of 10 per cent in the efficiency calculated from test data.

As a result of this uncertainty, an analysis was made to estimate the tare torque using data from all previous tests. Two methods, which are described below, were utilized to establish the sum of the torques of the hydrodynamic seal and the potassium turbine bearings as a function of shaft rotative speed.

Reference to Table III indicates that in some of the testing, the torque readings were made manually using a dial in the control room and in other tests, the digital data handling system was utilized to read torque values. Shown in Figure 18 is the variation of manually read torque with digitally read torque for the December calibration tests. It is apparent from the figure that the control room dial was reading eight or nine per cent below the value given by the digital. Since zero and full scale deflection were set with digital readings, these readings are considered to be more reliable than the manual readings. Figure 18 was used to correct the data of the April tare tests to digital level.

As was indicated above, the tare torque value sought is the sum of the torque absorbed by the hydrodynamic seal and the potassium turbine bearings, which can be stated by the following equation:

$$Q_{tt} = Q_{hs} + Q_{kb} \tag{16}$$

During the April tare test, sufficient thermodynamic data on the potassium supplied to the hydrodynamic seal was obtained to calculate the torque absorbed by this component. The torque of the hydrodynamic seal was calculated through the use of the following equation

$$Q_{hs} = \frac{(12)\ (60)\ J\ w\ c_{pk}\ \Delta T_k}{2\ \pi\ N} \tag{17}$$

Thus, it is only necessary to calculate the potassium turbine bearing torque as a function of rotative speed, to obtain the tare torque. The potassium bearing torque can be obtained from the following equation for tare testing

$$Q_{kb} = Q_{sd} - Q_{hs} - Q_{bs} - Q_{bw} \tag{18}$$

In evaluating Equation (18), the hydrodynamic seal torque was determined from Equation (17).

Since the tare torque data for April did not have potassium turbine torque meter readings, these readings were estimated from correlations of the water brake torque obtained during the December calibration tests. Shown in Figure 19 is the variation of water brake bearing and seal torque as a function of rotative speed with three values of water flow to the seals. The test data are also tabulated in Table III. For a seal water flow of 1 gpm, two test runs were made during the December water brake calibration test. In addition, data from a water brake calibration test made in June is added. The lines shown in Figure 19 were obtained by least-square fits of the data shown. The form of the equation used in the curve fit is as follows

$$Q_{bs} = K_{bs}\ N^{n}_{bs} \tag{19}$$

Referring to Equation (18), suitable values for all terms in the equation are now available either by direct measurement or from a suitable curve fit, except for the potassium bearing torque, Q_{kb}, and the blade windage of the two-stage turbine, Q_{bw}. The sum of these two torques, at about 14,700 rpm, was computed from the April test data and is shown plotted against the facility pressure in Figure 20. Except for the data point at 2.2 psia, the data defines a straight line. This is to be expected if the temperature of the argon in the facility is constant since the torque due to blade windage should be proportional to the density of the argon. By extrapolating the data to zero facility pressure, the potassium turbine bearing torque at a rotative speed of approximately 14,700 rpm can be obtained.

Assuming that the following equation is suitable for representing the blade windage,

$$Q_{bw} = K_{bw} \; N^2 \; P_f \tag{20}$$

the constant, K_{bw}, can be obtained from the data plotted in Figure 20.

Using this relationship for blade windage, the potassium bearing torque was calculated using Equation (18), and added to the torque of the hydrodynamic seal calculated with Equation (17), to obtain one estimate of the tare torque.

A second analysis of the data was carried out as follows. Using the bearing power plots presented in Figure 27 of Reference (11), variations in total shaft power with no hydrodynamic seal are plotted as a function of rotative speed in Figure 21. For the same test data, the

(11) E. Schnetzer: Two-Stage Potassium Test Turbine, Quarterly Report No. 9. Contract NAS 5-1143, August 8, 1963.

potassium turbine bearing power alone could be calculated from Equation (21) using the data of Table IV.

$$HP = \frac{J\ w\ c_{pl}\ \Delta T_1}{550} \tag{21}$$

(The specific heat of the lube oil is presented as a function of temperature in Figure 22.) These turbine bearing power data are also shown in the same figure. The differences between the curves through the open and closed symbols in Figure 21 then are the windage of the turbine disks in normal air since the tests were made without a turbine casing and without buckets. As is expected for a given rotative speed, the difference between any two corresponding curves having opened and closed symbols in Figure 21 is approximately constant. (An exception was the data for an inlet temperature of 130°F and a pad bearing lube flow of 2.25 gpm which was not used.)

Shown in Figure 23 is the average variation of the disk windage horsepower with rotative speed. By subtracting the values of Figure 23 from the values of total shaft power in Figure 21, a consistent set of parametric data typified by Figure 24 was obtained. Using Figure 24 for bearing loss and Equation (17) for the hydrodynamic seal, a second value of the tare torque was estimated.

The results of these two methods are summarized in Figure 25, where the tare torque is plotted against the rotative speed. The bottom line was calculated using the first approach and the top line was calculated using the bearing test data of Figure 24. Shown for comparison are the tare torque values through the tare test data for October 2, 1964. This tare torque curve was used for evaluation of the turbine test data. This tare torque curve lies between the two estimates of tare torque obtained by the methods outlined above. The two estimates of tare torque provide an estimate of the uncertainty in the tare torque measurement, and indicate that for future testing, an effort must be made to reduce this uncertainty. Steps to be taken to reduce tare torque uncertainties are discussed under Turbine Test Preparations.

c. Flow Rate

Another factor under critical examination is flow rate measurement. The turbine vapor flow rate is determined by measuring the liquid flow rate from the condenser. The condenser flow rate is split into two steams before flow measurement. One is the liquid spray flow, which permits inlet vapor quality control, and the other is the boiler feed flow. The flow rate in each stream is measured with electromagnetic flowmeters. The condenser liquid level is maintained constant during testing and for steady state conditions, the sum of the liquid flow rates is the flow rate through the condenser and the turbine. Analysis of Sanborn charts indicates that condenser level was not held constant for all test points and a preliminary check on the rate of change of liquid level indicates that flow rate errors of 10 per cent might not be uncommon.

To evaluate the accuracy of flow measurement during turbine testing, an attempt was made to correlate the flow measurement from the electromagnetic flowmeters with the differential pressure measurement at the turbine inlet annulus formed by the bullet nose and the inlet duct. For the vapor, the continuity equation can be written:

$$X_3 W = \frac{V_{x3} A_3}{v_{sat\ 3}} \tag{22}$$

From compressible flow theory,

$$V_{x3} = \sqrt{2g\ P_{t3}\ v_{t3}\ \left(\frac{n}{n-1}\right)\ 1 - \left(\frac{P_{s3}}{P_{t3}}\right)^{\frac{n-1}{n}}} \tag{23}$$

but

$$P_{t3} = \frac{P_{t3} - P_{s3}}{1 - P_{s3}/P_{t3}} \tag{24}$$

therefore

$$V_{x3} = \sqrt{2g\ v_{t3}\ (P_{t3} - P_{s3})}\ \sqrt{\left(\frac{n}{n-1}\right)\left[\frac{1 - (P_{s3}/P_{t3})^{\frac{n-1}{n}}}{1 - (P_{s3}/P_{t3})}\right]} \tag{25}$$

Substituting for V_{x3},

$$X_3W = \frac{A_3}{v_{sat\ 3}}\ \sqrt{2g\ v_{t3}\ (P_{t3} - P_{s3})}\ \sqrt{\left(\frac{n}{n-1}\right)\left[\frac{1 - (P_{s3}/P_{t3})^{\frac{n-1}{n}}}{1 - (P_{s3}/P_{t3})}\right]} \tag{26}$$

But for pv^n = constant

$$v_{s3} = v_{t3}\ (P_{t3}/P_{s3})^{1/n} \tag{27}$$

therefore

$$X_3W = \frac{A_3\ \sqrt{2g\ v_{t3}\ (P_{t3} - P_{s3})}}{v_{t3}\ (P_{t3}/P_{s3})^{1/n}}\ \sqrt{\left(\frac{n}{n-1}\right)\left[\frac{1 - (P_{s3}/P_{t3})^{\frac{n-1}{n}}}{1 - (P_{s3}/P_{t3})}\right]} \tag{28}$$

or

$$X_3W = \frac{A_3}{(P_{t3}/P_{s3})^{1/n}}\ \sqrt{\frac{2g\ (P_{t3} - P_{s3})}{v_{t3}}}\ \sqrt{\left(\frac{n}{n-1}\right)\left[\frac{1-(P_{s3}/P_{t3})^{\frac{n-1}{n}}}{1-(P_{s3}/P_{t3})}\right]} \tag{29}$$

Flow rates were calculated using these equations and compared with those from the electromagnetic flowmeters. These data are tabulated in Table V and plotted in Figure 26. The data for an inlet temperature of 1550°F indicated a fairly good correlation but the data for 1450°F had more scatter than could be tolerated.

In the previous analysis, it was assumed that only the vapor should be considered in the continuity equation and that the vapor density should be that of saturated vapor. In the quest for a better correlation, an alternate analysis was made in which it was assumed that all of the potassium would be considered in the continuity equation and the vapor density would be that corresponding to the vapor quality. For these assumptions, the continuity equation was written:

$$W = \frac{V_{x3} A_3}{v_3} = \frac{V_{x3} A_3}{X_3 (v_{sat\ 3})} \tag{30}$$

$$V_{x3} = \sqrt{2g\,(P_{t3})\,(X_{t3})\,(v_{sat\ t3})\left(\frac{n}{n-1}\right)\left[1 - (P_{s3}/P_{t3})^{\frac{n-1}{n}}\right]} \tag{31}$$

and

$$W = \frac{A_3}{X_3 (v_{sat\ 3})} \sqrt{2g\, X_{t3}\,(v_{sat\ t3})\,(P_{t3}-P_{s3})} \sqrt{\left(\frac{n}{n-1}\right)\left[\frac{1-(P_{s3}/P_{t3})^{\frac{n-1}{n}}}{1-(P_{s3}/P_{t3})}\right]} \tag{32}$$

but

$$X_3 (v_{sat\ 3}) = X_{t3} (v_{sat\ t3}) (P_{t3}/P_{s3})^{1/n} \tag{33}$$

therefore

$$W = \frac{A_3}{(P_{t3}/P_{s3})^{1/n}} \sqrt{\frac{2g\,(P_{t3}-P_{s3})}{X_{t3}\,(v_{sat\ t3})}} \sqrt{\left(\frac{n}{n-1}\right)\left[\frac{1 - (P_{s3}/P_{t3})^{\frac{n-1}{n}}}{1 - (P_{s3}/P_{t3})}\right]} \tag{34}$$

Flow rates were also calculated using these equations and compared with those from the electromagnetic flowmeters. Although there was not much difference in the results of the two calculation methods, the first one gave a slightly better correlation and is considered preferable.

An investigation was made to determine reasons for the discrepancy of some points. One factor that appears to be a major cause is that the condenser liquid level was not held constant during some test points. The flow measuring system is based on measuring the liquid flow rate out of the condenser. The turbine flow rate is equal to the condenser flow rate only when the condenser liquid level is held constant. An attempt was made to correct the electromagnetic flow meter measurements for the rate of change of condenser liquid level. However, the condenser liquid level is measured by means of a cesium source. The instrument requires 30-60 seconds to indicate 63.5 per cent of a level change. Therefore, it was difficult to get an accurate slope from the Sanborn trace of condenser liquid level and the results are considered qualitative rather than quantitative.

The free liquid surface in the condenser was calculated to be 1620 in^2. The flow rate correction was calculated as

$$\frac{dw}{dt} = \rho_L A \frac{dh}{dt} \tag{35}$$

where ρ_L is the density of liquid potassium, A is the free liquid surface in the condenser, and $\frac{dh}{dt}$ is the rate of change of condenser liquid level. Substituting numerical values:

$$\frac{dw}{dt} = 47.5 \text{ lb/ft}^3 \quad \frac{1620 \text{ in}^2}{1728 \text{ in}^3} \quad \frac{\text{ft}^3 \text{ min}}{60 \text{ sec.}} \quad \frac{dh}{dt} \quad \frac{\text{in}}{\text{min}} = 0.743 \frac{dh}{dt} \qquad (36)$$

Shown in the last column of Table V are the electromagnetic flowmeter flow rates corrected for liquid level in the condenser. Some of the 1450°F and all of the 1550°F data points had condenser liquid levels that were quite steady and no corrections were made for these points.

Most of the corrections were in the proper direction to improve the correlation with bullet nose flow rates, but for point 8, the correction was in the wrong direction and for point 28, the magnitude of the correction was too great. A remarkable thing about the corrections is that for points 9 and 39, the slope was estimated at 0.6 in/min, which gives a flow correction of 0.45 lb/sec, which is over 20 per cent of the flow rate, and this correction brought these points into good agreement with the bullet nose flow rate calculation.

Shown in Figure 26 is a flow rate comparison between the bullet nose flow rate calculation and the electromagnetic flowmeter calculations, corrected for condenser liquid level. As discussed above, the correlation was improved except for points 8 and 28. Although the corrections for condenser liquid level must be considered approximate, they do tend to substantiate the flow rates calculated from the bullet nose pressure measurements.

One conclusion from this investigation is that more care must be taken to maintain a constant condenser liquid level during test points if the electromagnetic flowmeter measurements are to be used for turbine flow rate. A second conclusion is that the bullet nose pressure differential measurement is a feasible way to measure vapor flow rate. The liquid flow rate measurement, at least of the spray flow, would still be required to determine quality at the turbine inlet station. In future tests, the turbine flow rate will be determined using the bullet nose annulus pressure differential measurement.

2. Experimental Performance

Shown in Table VI are data taken during testing of the two-stage turbine in potassium vapor. These data were reduced using tare torque as a function of speed to the 1.3 power as discussed above and shown in Figure 17. Shown in Figure 28 is a plot of total to total pressure ratio versus rotative speed for 1450°F turbine inlet temperature and zero spray flow. Total to total pressure ratios of 2.1, 3.2 and 3.6, all with a tolerance band of ± 0.1, were selected for comparison with the predicted performance.

Shown in Figures 29 and 30 are the variations of total to total turbine efficiency with rotative speed, for total pressure ratios of 2.1 and 3.2, respectively. The curves represent predicted performance and the symbols represent experimental data. These plots show that the test data is about 20 - 30 points lower in efficiency than the predicted performance. This is consistent with the test data for 1550°F inlet temperature.

Shown in Figure 31 is a similar plot of total efficiency versus speed for a total pressure ratio of 3.6 ± 0.1. There is a very significant difference in this plot; namely, that some of the test data points agree with predicted performance. The shaded symbols represent data points taken on October 8, 1964, the date on which most of the test data were taken. They show the familiar, but unexplained discrepancy of 15 - 20 points in efficiency between predicted and test performance. The unshaded symbols represent data points taken on October 4, 1964 and prior to that date. It now appears that the poor turbine performance measured on October 8, 1964 is due to damage sustained by the turbine during several instrumentation leaks.

On three occasions, there were potassium leaks due to failures of instrumentation lines at the turbine casing. The fires resulting from the contact of hot potassium with the air were localized although the fire on October 4, 1964 was somewhat greater than the previous ones. After each incident, the faulty instrumentation lines were repaired and testing was resumed. Subsequent disassembly of the turbine revealed that significant damage had been done to the turbine flow passage.

Air was drawn into the turbine at the bottom of the casing causing the potassium to burn through the second-stage nozzle-diaphragm outer band. The potassium also burned 0.25 inch pieces off the trailing edge (length 0.985 in.) of each of the five nozzle diaphragm partitions near the hub. More serious was the loss of about 5 inches around the periphery of the second stage tip seal, resulting in an average increase in tip clearance of 32 mils. Inspection at the end of the test also revealed extensive erosion and/or corrosion damage to the first stage buckets, resulting in sharp leading edges. The turbine performance apparently was adversely affected by the loss of parts of the nozzle diaphragm, the tip seal and the sharp leading edges of the first stage buckets. Other damage consisted of erosion and/or corrosion of nozzle diaphragm partitions and the second stage buckets. The contribution to losses in efficiency due to this latter damage is not thought to be large.

Although the turbine sustained considerable damage as determined by inspection after testing, it is difficult to explain the entire degradation in performance by this damage.

Shown in Figures 32, 33 and 34 are corrected flow as a function of rotative speed for 1450°F inlet temperature and no spray flow. For all three values of turbine pressure ratio, the measured flow rate is 10 to 20 per cent higher than predicted.

Shown in Figures 35, 36, and 37 are the variation of turbine power output as a function of rotative speed for the 1450°F test conditions. At turbine pressure ratios of 2.1 and 3.2, the power output is lower than predicted. These data were taken on 10/8/64 after the turbine had been damaged due to potassium leaks and the subsequent fires. For a turbine pressure ratio of 3.6, shown in Figure 37, there is data before and after 10/4/64 when the worst fire occurred. The open symbols represent performance data taken before the fire and show power output higher than predicted. The shaded symbols for data taken on 10/8/64 show that performance was reduced due to the fire damage.

Shown in Figures 38 and 39 are the variation of flow and power output as a function of rotative speed for 1550°F inlet temperature, no spray flow, and a turbine pressure ratio of 3.0. The flow is about 10 per cent higher than predicted and the power output is 10 to 15 per cent lower than predicted. Similar plots for a pressure ratio of 3.8 are shown in Figures 40 and 41. Again, the flow is about 10 per cent higher and the power output 10 to 15 per cent lower than the predicted values.

The effect of quality on turbine efficiency is shown in Figures 42 and 43 for 1450°F and 1550°F inlet temperatures and design speed. The paucity of the test data and its scatter do not permit a quantitative conclusion but the data taken at lower quality indicate that performance is less than at higher quality. All of the test points shown have performance much lower than predicted.

All of the performance data presented so far was based on the tare torque values shown in Figure 17. Because of the uncertainty in tare torque, as discussed earlier in this report, the upper and lower lines of Figure 25 were also used for some data to indicate the effect of this uncertainty on turbine efficiency. The following figures show the variation of turbine performance with tare torque.

Shown in Figure 44 is the variation of turbine efficiency with rotative speed at 1450°F turbine inlet temperature, zero spray flow, and turbine pressure ratio of 3.6 ± 0.1. For comparison, the turbine efficiency values with the higher and lower tare torques of Figure 25 are shown in Figure 45. The lower tare torque values result in 3 per cent lower efficiency at lower speeds to 5 per cent lower efficiency at high speed. The higher tare torque values result in 3 per cent higher efficiency at lower speeds to 10 per cent higher efficiency at higher speeds. This variation in turbine efficiency is due to the uncertainty in tare torque.

Shown in Figures 46 and 47 are similar efficiency comparisons for 1450°F inlet temperature and a turbine pressure ratio of 3.2. Although these comparison plots show the same trends, all of the data are lower than predicted performance since the data were taken on 10/8/64 after the turbine had been damaged as described previously. Similar comparison plots are shown in Figures 48 and 49 for 1450°F inlet temperature and a turbine pressure ratio of 2.1. These data from 10/8/64 have considerable scatter and indicate poor turbine performance.

Shown in Figures 50 and 51 are the turbine efficiency comparisons for 1550°F inlet temperature, zero spray flow, and a turbine pressure ratio of 3.8. These data were taken on 10/8/64 and indicate the lower than predicted performance levels due to the damage suffered by the turbine during previous testing. Similar efficiency comparisons are shown in Figures 52 and 53 for 1550°F inlet temperature and a turbine pressure ratio of 3.0.

C. TURBINE TEST PREPARATIONS

As indicated above, the largest measurement errors uncovered during data reduction were in flow rate and torque measurement. Refinements planned for these measurements are discussed along with a number of other lesser instrumentation changes.

1. Flow Measurement

In the DATA REDUCTION section, it was pointed out that non-constant liquid level in the condenser resulted in sizeable flow measurement errors during testing last September and October. Consequently, the bullet nose annulus instrumentation which was used successfully to sense velocity transients during previous performance testing will be utilized to measure steady state flow during the next performance test. A calibration test of the bullet nose annulus instrumentation was made in the Flow Analysis Calibration Test (FACT) stand using air. The bullet nose annulus and the first stage nozzle diaphragm were used for this calibration test.

The objectives of the calibration test were:

- Experimentally calibrate the two-stage turbine bullet nose annulus instrumentation in air so that it can be used as the primary flow measurement device during turbine potassium vapor performance testing.
- Experimentally calibrate the instrumentation in the first-stage nozzle diaphragm in air so that it can be used as an alternate flow measurement device during turbine potassium vapor performance testing.

- Experimentally determine the first-stage nozzle diaphragm effective flow area.

Shown in Figure 54 is the test equipment, which is comprised of the turbine inlet bullet nose, the first-stage nozzle diaphragm and the first-stage tip seal (see Figure 54), installed in the FACT stand. Upstream of the bullet nose, there was a calibrated ASME flow nozzle followed by a constant-area flow duct connected to the bullet nose. The instrumentation stations are also shown in the figure.

Shown in Figure 55 are the locations of the bullet nose annulus instrumentation. This instrumentation consists of four total pressure probes and four static pressure taps. Three of the total pressure probes are located at the mid-point of three equal annulus area sections with an additional total pressure probe located 109 degrees away at the mid-point of the annular flow area. The static pressure taps include two pairs of hub and tip taps located 180 degrees apart. During the calibration testing, each total pressure was recorded along with four total to static differential pressure combinations. These pressure differential measurements (delineated in Table VII) were measured using pressure differential transducers connected between the desired taps. Although only one pair, Items #21 and #25 (Reference Table VII), will be used during actual turbine potassium vapor performance test, sufficient calibration data will be available in the event an alternate pair of instruments is required (because of plugging or any other reason).

In the first-stage nozzle diaphragm, a tip and a hub static pressure tap are located near the diaphragm exit (see Figure 54). These static pressure readings were recorded during the calibration tests and, along with the inlet bullet nose total pressure readings, provide an alternate method of flow determination.

In the constant area duct, preceding the bullet nose and first-stage nozzle diaphragm assembly, there are two total temperature thermocouples located approximately 20 inches upstream of the bullet nose as shown in Figure 54. Two static pressure taps are located in the pipe wall at the ASME nozzle exit which along with two total pressure and two total temperature probes located upstream of the ASME nozzle, enable the flow to be determined.

The summary of the readings which were recorded during the calibration test on a digital system is shown in Table VII. All total and static pressures were measured using 0 - 50 psia transducers with a measurement accuracy of $\pm .1$ per cent of full scale. Thus, the maximum absolute error was $\pm .05$ psia. Temperature measurement accuracy was within $\pm 4^{\circ}F$ over the testing range.

The test point schedule is presented in Table VIII. Testing began at the high inlet pressure test point (31.0 psia) and three digital scans per test point were taken. Once all the test points had been run, they were repeated taking three digital scans per test point to insure repeatability. During the testing, the inlet air dew point temperature did not exceed $-31^{\circ}F$ and inlet air temperature was ambient (approximately $30^{\circ}F$). Stable flow conditions through the test assembly were assured by holding the maximum total pressure variation to less than ± 0.2 psia.

2. Torque Meter Modification and Calibration

Shown in Table IX are typical torque errors arising from the use of the torque measuring system shown in Figure 16. The torque readings shown in this table were taken from a potassium turbine performance test point in which the inlet temperature, rotative speed, and total-to-total pressure ratio were 1482°F, 19,468 rpm and 3.15, respectively. The total torque is made up of four torque readings, each having a certain error. Because of its large full scale reading, the potassium-turbine torque meter can potentially introduce about ± 13 inch-pounds of error whether it is used for tare or performance testing by actual bench calibration (Manufacturer guarantees no more than ± 2 in.lb.). The steam turbine torque meter, having a much smaller full scale reading, contributes a maximum of ± 1.96 inch-pounds of error for either performance or tare testing by actual bench calibration (Manufacturer guarantees no more than ± 2 in. lb.). The large potential error in potassium-turbine torque-meter reading during tare testing can be substantially reduced by the use of a smaller torque meter. However, for performance testing, a full-scale-reading of 1000 in.lb. is required of the torque meter. After studying several approaches to the problem, it was decided to provide two alternative solutions which could be compared. The first of these was to secure strain elements for the potassium-turbine torque meter such that the full scale reading was reduced by one-half to 1250 inch-pounds. The second approach was to use a torque arm actuating a load cell. For tare testing, a small full-scale-reading load cell could be utilized while for performance testing, a larger full-scale-reading load cell could be utilized. By mounting the load cell in a readily accessible location, it could be changed between tare and performance testing with a minimal effort.

Shown in Figure 56 is an assembly drawing showing the modifications in water brake mounting arrangement necessary to permit the use of load cells to measure potassium turbine torque. The casing of the water brake is cradled between tapered roller bearings, permitting the free rotation of the water brake casing as it absorbs torque. The rotation is restrained by a frame-mounted load cell which presses against a load arm bolted and rabbeted to the water-brake casing. The details of the load cell mounting are shown in Figure 57. Two load cells are to be provided, a 25 pound and a 100 pound. The first results in a full scale torque reading of 375 inch pounds and the second 1500 inch pounds. The first will be utilized in tare testing and the second in performance testing. The load cells have a maximum deflection of no more than 0.0008 inches and an accuracy of 0.25 per cent of full scale or 0.94 inch pounds for the first and 3.8 inch pounds for the second. The small (nearly negligible) deflection is expected to minimize extraneous torques caused by the water brake water hoses when the water brake casing rotates.

Shown in Table X are target values of torque measurement error which can be compared with similar values in Table IX. A maximum error of 13.4 inch-pounds would result in 3.08 per cent error in torque (and efficiency) for the typical data point tabulated.

Since a bench calibration of the potassium-turbine torque meter indicated a full scale accuracy of $\pm$ 0.52 per cent ($\pm$ 13 in.lb.) and since the water brake calibration test of December, 1964 indicated non-consistent values of potassium-turbine torque on two runs (test date, December 14, 1964) under similar conditions, (see Table III), it may be concluded that the errors in torque are not confined to the torque measuring system. Although the fluid connections to the steam turbine and water brake are designed to produce minimal torque reactions, it is conceivable that under certain conditions of operation, these connections could be producing torque and thus, cause indeterminate errors in torque readings.

As a result, bench calibrations will be made of the two load cells as well as the potassium and steam turbine torque meters. After installation, dead-weight calibrations will be made prior to the connection of the fluid lines. The calibrations will be repeated with the fluid lines in place. Finally, a calibration will be made during rotation of the steam turbine and water brake alone. This series of calibration testing should make possible the identification of the major sources of torque measurement errors. When these sources of error have been identified, all possible means will be utilized to minimize them.

3. Turbine Test Instrumentation

a. Location

Shown in Figure 58 is a schematic diagram showing the test turbine performance instrumentation stations. For overall performance, the primary stations are 1, 3, 7 and 8. Stations 4, 5 and 6 in the figure are internal to the turbine and are useful in finding load distribution and stage reaction. Shown in Figures 59 and 60 are schematic diagrams showing the location and number of sensors in each of the instrumentation stations. Station #2, which is associated with the liquid injector, has been retained because the injector itself is still fitted. However, this injector will not be used in these tests. The details of the instrumentation at each of these instrumentation stations are delineated in Figure 57.

Delineated in Table XI is the instrumentation to be used for the determination of performance of the potassium turbine. Shown in the table are the parameters to be measured, its location, range, type of sensor and readout. Shown in Table XII is a list of the instruments to be continuously recorded during performance testing. The instruments listed in this table will be used to establish test points, study transients if they should occur, and monitor measurements essential to the safety of the test turbine during performance testing. The turbine inlet pressure, which will range from 10 to 35 psia on the Sanborn, will be set for each test point by reference to Channel B-5. The pressure ratio across the turbine will be established from Channel B-6 which records the total pressure differential between stations 3 and 7. This channel will measure differential pressure in the range 0 to 25 psig. The pressure ratio depends upon the setting of a condenser pressure. This pressure will be read on Channel C-4 which will be connected to the Taylor gage at station 8.

Since the last series of performance tests, a number of important changes in instrumentation have been made. These changes are listed in Table XIII where reasons for the addition or changes in the measurement are described.

b. Turbine Efficiency Measurements

Turbine efficiency will be calculated from the following five types of measurements: efflux system pressure, vapor flow, torque, temperature and speed.

The inlet and exit pressure of the test turbine will be obtained from the total head tubes which are part of the efflux measuring system and are located at stations 3 and 7. Shown in Figure 61 is the schematic diagram of this pressure measuring system. Argon flows at the approximate rate of 1 x 10^{-5} pps per sensor line from a manifold through a filter, an efflux system assembly, a solenoid valve, a vapor trap (shown in Figure 62) and into the test vehicle. The flow of argon is metered by means of a small orifice in the efflux system assembly. The flow of argon prevents potassium vapor from entering the pressure measuring system. In order to increase the accuracy of the readings with this system, the argon is turned off momentarily by means of the solenoid valve during the taking of a reading. During this interval any vapor which would attempt to flow up stream in the pressure measuring system is stopped at the vapor trap. A lead connects the scani-valve to a tee which is between the solenoid valve and the vapor trap. This scani-valve is a fluid switch permitting 12 separate pressures to be read on the same precision transducer. The scani-valve and the solenoid valves for each pressure measuring line are controlled by the digital data handling system circuitry so that the transducer is vented to the test vehicle for approximately 4 seconds before the digital data handling system secures a reading.

The flow measuring technique for performance testing has been improved by instrumenting the bullet nose annulus (cross section A in Figure 57) to measure flow. A differential pressure transducer connects a total head tube and a static tap (items 20-24 in Table XI), permitting the measurement of total to static pressure differential in the bullet nose annulus. The calibration curve for the bullet nose annulus is being determined from the air calibration test data.

Although the inlet and exit conditions of the turbine are obtained from pressure measurements, some temperature measurements are also necessary in order to calculate efficiency. At station 1, there is a throttling calorimeter requiring the measurement of both a pressure and a temperature. The pressure is measured by means of the efflux system and the temperature is measured with a C-A thermocouple. The reference temperature for all of the thermocouples including the calorimeter is measured by means of a thermister in the copper alloy thermal sink (CATS). In addition, thermocouples at stations 3 and 7 are utilized to validate static pressures measured with the efflux system at these same stations. This is done by calculating the vapor pressure which corresponds to the measured temperature.

The speed of the turbine is measured by means of an Eput meter actuated by a six tooth gear on the turbine shaft. The Eput meter generates a DC signal which is proportional in voltage to the speed of the turbine. This device is calibrated against a Berkeley counter.

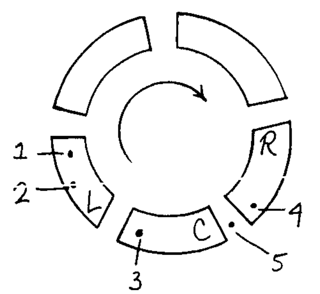
Shown in Table XIV are the estimated accuracies of those measurements which enter into the determination of turbine efficiency.

c. Test Measurements

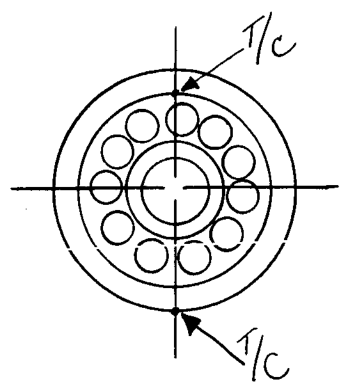
In this test, much of the instrumentation involved is intended to monitor operation of the mechanical system to insure safe operation, and identify its dynamic characteristics. The rotor dynamic and critical speeds are sensed by accelerometers and velocity pickups located within the potassium turbine and on the rear of the starter turbine as shown in Figure 63.

Figure 63 also shows the several temperatures on the test rig which are both monitored and recorded during running. These comprise bearing temperatures for each of the test rig components.

Temperatures are measured in the two bearings of the test turbine as shown below.



Pivoted Pad Bearing



Ball Thrust Bearing

Besides the several measurements discussed in TURBINE EFFICIENCY MEASUREMENTS SECTION, a large number of additional measurements, as delineated in Table XI, are made on the various pieces of readout during performance testing. Shown in Table XV are estimates of the accuracy of a number of these instruments.

III MECHANICAL DESIGN

GENERAL

The activity this quarter has been the removal and major disassembly of the turbine following the testing of October, 1964, and its rebuild and installation in the facility for resumption of testing.

A. TURBINE TESTING

During the testing on potassium vapor of October, 1964, the turbine was operated for 35 hours at temperatures exceeding 1432°F (and up to 1582°F) as reported in reference (2). This testing was devoted to obtaining performance data. Of a total of 114 test points, 103 were obtained at speeds ranging between 16, 000 and 20, 000 rpm. During testing, the turbine mechanical system functioned satisfactorily although testing was accompanied with a constant variation in turbine speed of about ± 2000 rpm and sudden speed drops (e.g. 15000 rpm to 3000 rpm in two seconds) which were diagnosed as boiler instability.

Of specific significance was the fact that the forward pad bearing never exceeded surface temperatures of 200°F, even at speeds of 20, 000 rpm and vapor inlet temperatures of 1582°F. The rotor balance remained constant throughout testing at the initial low level of 0.5 gram/inch residual unbalance, as indicated by accelerometers and shaft capacitance gages. The hydrodynamic seal provided effective sealing and separation of oil and potassium vapor

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(2) E. Schnetzer: Two Stage Potassium Test Turbine, Quarterly Progress Report No. 14. Contract NAS 5-1143, NASA - CR 54285, November 8, 1964.

throughout the testing. Rotor to stator, radial and axial clearances had been adequately set, as evidenced by smooth running and teardown inspection. Testing was limited to day shift operation. At night the facility was kept on standby, with the boiler at 1000°F and the turbine at 3,000 rpm on steampower.

Testing was accomplished in nine (9) individual runs. Several interruptions in testing were caused by leaks primarily in welds of instrumentation lines. Testing had to be terminated when, on October, 13, the main facility boiler developed a leak in the upper boiler drum, above the liquid level line. During boiler repair it was considered advisable to thoroughly inspect the turbine including its fluid dynamic parts.

B. POST-POTASSIUM TEST TURBINE INSPECTION

As discussed in reference (2), the first phase of turbine inspection involved removal and disassembly of the bearing housing - bearing - hydrodynamic seal assembly, while leaving the turbine rotor assembled and in place in the facility. This inspection revealed a small potassium leak out of a ruptured welded plug in the hydrodynamic seal inlet line, and argon leakage from cracks in the sheet metal cover on the bearing housing covering the various flow tubes. The second step in turbine inspection involved opening the forward flange of the turbine by grinding its weld, and separating the inlet duct from the turbine approximately three (3) inches as shown in Figure 64. This allowed a visual inspection of

(2) E. Schnetzer: Two Stage Potassium Test Turbine, Quarterly Progress Report No. 14. Contract NAS 5-1143, NASA - CR 54285, November 8, 1964.

the turbine inlet region, which immediately revealed the following two problems:

1. Gross erosion of the inlet region of the turbine.
2. Damage to the outer band of the second stage nozzle diaphragm as a result of fire caused by a leak in a pressure efflux line weld.

For thesereasons, the turbine was removed from the facility for repairs.

The scroll exit flange was cut and the turbine was removed from the facility. The weld flanges showed no deterioration, and were cut open without difficulty, although their inner cavity contained potassium. Figure 65 is a frontal view of the turbine immediately after removal, and Figure 66 shows the parts after opening the turbine.

Visual inspection of the rotor and stator parts indicated that they were structurally intact with all strength members and rabbetted joints in original assembly conditions. Station #7 instrumentation suffered no erosive deterioration during testing; however, erosion on the leading edges of some of the turbine inlet total pressure probes at Station #3 was encountered.

The rotor bearings showed no evidence of deterioration. The forward pad bearing to housing fit changed from a .0009" to .0010" radial clearance which indicates that the radial key support incorporated prior to this testing was successful in accomplishing rigid rotor support.

A thorough dimensional inspection was performed on all disassembled parts. The post-test inspection of the labyrinth seals showed that although most of the stationary seal surfaces had gone out-of-round during testing, the only rubbing which occurred was on the shaft screw seal teeth under the hydrodynamic seal forward inner diameter. The resulting rub spots on the stationary seal surface were diametrally opposite each other at 3 and 9 o'clock, each covering approximately a 40° arc of surface, and to a depth of .004 in. The oil screw seal on the forward surface of the pivoted pad bearing showed no rubbing. The argon labyrinth seals adjacent to the hydrodynamic seal showed slight "touch" lines. No measurable diametral change in the labyrinth teeth could be found.[2]

Severe damage on stator parts was created by fire resulting from an instrumentation leak.

The rotor, especially in its first stage, had suffered from erosion damage. Both of these require special attention and are discussed in more detail:

1. Damage Caused by Instrumentation Leaks

When an instrumentation tube weld leak was encountered on October 4, 1964 (reference 2), air was drawn into the turbine at the bottom-most point of the casing, where it burned through the forward second stage nozzle diaphragm outer band, and then through the nozzle vanes, damaging the trailing edge of three vanes and a segment of the honeycomb seal shown in Figure 67 and Figure 68 after casing disassembly. The honeycomb seal shows evidence of a local tip-rub due to the distortion in the vicinity of the

(2) E. Schnetzer: Two Stage Potassium Test Turbine, Quarterly Progress Report No. 14. Contract NAS 5-1143, NASA - CR 54285, November 8, 1964.

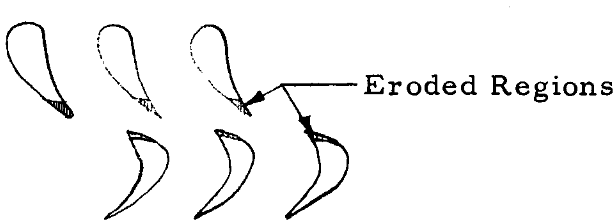
fire. If expressed in tip clearance area increase due to removal of a local section of honeycomb by the fire, it resulted in an increase of 0.54 square inches, or 73% increase in turbine tip clearance.

Figure 69 and 70 show the second stage nozzle diaphragm after further disassembly from the casing. The upper half of the turbine casing suffered no damage as shown in Figure 71. Also, the outlet guide vane assembly shown in Figure 72 showed no deterioration.

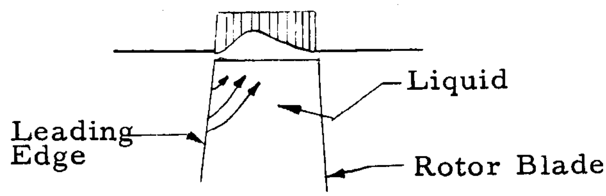
The outer periphery of the first stage rotor tip seal and two retaining bolts also showed fire damage, as indicated in Figure 73. However, this caused no operational problems.

2. Damage Caused by Erosion

The turbine inlet region showed a classical erosive pattern, wherein liquid entering through the nozzles at low velocity is struck by the suction surface of the fast-moving turbine blades, and is thrown back into the aft face of the nozzle vanes, eroding them as well as the turbine blades.



The radially-outward thrown liquid eroded the leading edge of the honeycomb tip seal, as shown below, and in detail in Figure 74 (a).



This shows that the first stage tip clearance opened from .022 inches to a maximum of .065 inches due to erosion of the honeycomb. Also shown is the fore-to-aft contour of the erosion pattern in relation to the rotor blades. There was no measurable change in the wheel tip diameter.

Figure 75 shows a close-up of the rotor with a new blade in place of one of the eroded blades for comparison purposes (the new blade has never been tip-ground; therefore, the length difference is not significant). Erosion of the blade leading edge and an eroded region beneath the blade platform can be seen on the side of liquid impact.

A detailed comparison of new and eroded turbine blades is shown in Figure 76. The erosion undercut beneath the platform is shown in Figure 77. The suction surface and pressure surface of a typical stage 1 eroded blade are shown in Figure 78, Figure 79 compares the tip section of a new and an eroded stage 1 blade. Figure 80 shows a comparison of used stage 1 and stage 3 fasteners with a new blade fastener, and shows erosion of the stage 1 fastener, During testing, five blades retaining fasteners of René 41 material broke with loss of the forward tab. Centrifugal force of the blades locked them in place in the dovetail to prevent axial movement. All the fasteners had been heat-treated prior to installation for maximum strength, and were somewhat stiff when bent. Although they had been fluorescent-penetrant inspected following bending and found free from crack indications, it is probable that unobserved microcracks, coupled with erosion allowed failure of the fasteners.

A close-up of erosion of the stage 1 tip seal and aft face of the first stage nozzle diaphragm assembly is shown in Figure 81.

It is significant that the second stage shows much less erosion on both rotating and stationary parts, even though about 3% more moisture (at design point of 19000 rpm and 2.95 pressure ratio) is present in the second stage. The nozzle diaphragm outlet was not eroded, as shown in Figure 82, and the honeycomb seal and turbine blades have been eroded to a much lesser extent than stage 1, as shown in Figure 74b and 83, showing the erosion of the honeycomb seal and a typical stage 3 blade respectively.

This lesser eroded condition is attributed to:

1. The fine mist generated by the first stage, which reduced the droplet impact forces on the stage 2 components.

2. Stage 2 liquid and vapor is cooler than is stage 1, which lowers its solubility for metallic impurities, thereby decreasing its metallurgical attack on stage 2 components.

The former conditions support the original argument for a two stage turbine, which allows the first stage to be sacrificed to generate realistic turbine fluid conditions for testing of the second stage. (For example, the program for testing refractory blades involved blades for only the second stage.) However, the erosion of the first stage encountered here is much more severe than was originally anticipated.

Comparison of before-test and after-test blade weights revealed an average weight loss, due to erosion, of 6.7% for stage 1 and 0.7% for stage 2.

C. ANALYSIS OF OPERATIONAL PROBLEMS

The fire damage incurred was due to weld-failures at the joints between the instrumentation stubs on the turbine casing and the extentions of 1/4 inch efflux pressure tubing at a 2 inch distance from the outside of the turbine casing. In future testing, these weld joints will be strengthened, and will be further removed to a 4 inch distance from the casing surface where they will be outside the casing insulation and open to visual inspection.

The erosion is attributed primarily to the excessive amounts of liquid carried into the turbine for the following likely reasons:

1. The establishment of low vapor inlet quality by pre-injection of fluid implies that duct and bullet nose surfaces upstream of the turbine inlet are exposed to this low quality vapor flow. As a result, considerable amounts of liquid are collected on these surfaces by contact. This mechanism of liquid formation is believed to be rather independent of droplet size, but being primarily a function of quality. The situation may be aggravated by injected fluid hitting these surfaces directly. This latter effect could be eliminated by extreme atomization of the injected flow.

   A redesign of the liquid injection system has been considered, however, based on an agreement with NASA, no immediate changes are made. Possible changes of the injection system are deferred until the results of the next forty hours of testing without liquid injection become available.

2. Liquid carryover from the boiler has been suspected as an additional cause for erosion. This, however, could never be established by measurements. The quality meter at Station 1 with its digital readout never gave an indication of liquid carryover. It consistently read 98 to 99 per cent quality.

3. The 1 to 2 per cent moisture resulting from the 98 to 99 per cent quality at turbine inlet may also be a contributor to blade erosion,

especially when accumulation of corrosive impurities in the boiler is considered.

During the 35 hours vapor operation, liquid was intentionally sprayed into the turbine inlet for a total of approximately 9 hours to obtain controlled inlet quality at temperatures between 1450°F and 1550°F and at speeds up to 20,000 rpm. The distribution of spray flow vs time is shown in Figure 84 by date.

Assuming all flow between 0 and 1 gpm to be at 0.5 gpm, and all flow between 1 and 2 gpm to be at 1.5 gpm, etc., Figure 84 shows that, prior to the instrumentation leak on October 4, 38% of the total spray flow had been injected into the turbine. It must be concluded therefore, that some of the loss of turbine efficiency observed after the leak on October 4 can be attributed to blade erosion prior to this date.

It is not known whether boiler carryover is present during turbine operation and if so, how much liquid is involved. However, a liquid vapor separator has been installed on the boiler to prevent carryover of liquid into the turbine. The separator was designed by GE, and manufactured by Hutton Manufacturing Company, and incorporates a Centrifix Corporation type 8 inch F R separator as its core.

D. TURBINE REWORK

The turbine rework performed was for the purpose of replacing and repairing the fire-damaged and eroded parts discussed previously. The modifications made for continuation of potassium testing are:

1. Replacement of turbine rotor with a new one of the same design as previously used.

2. A new bearing housing cavity cover incorporating an expansion bellows for greater tolerance to thermal expansion, to prevent cracking during testing.

3. Redesign of blade retaining clips for greater strength and initial ductility.

4. Installation of a Taylor pressure gage at station #7, and at station #1.

5. Strengthening of instrumentation tubing and improved welding design.

1. Turbine Rotor

The rotor was replaced with a new one made of available spare parts. All parts were new except for the blades, which had been used during steam pre-testing, and the rear end internal spline coupling. The blade retainer clips were increased in thickness from .020 to .030 inches for increased resistance to erosion and were installed in the solution heat-treated condition to obtain maximum ductility during the bending process to prevent incipient cracking. The rotating components were first balanced separately, and then as an assembly. The balancing of the entire rotor resulted in less than 0.5 gram-inch residual unbalance.

2. Turbine Stator

The static flow path components are mechanically and aerodynamically consistent with the original design. A number of stator parts were replaced with new ones because of the previously discussed testing damage. These included honeycomb tip seals for both stage 1 and 2, interstage honeycomb seal, and turbine casings. The second stage nozzle diaphragm was reworked by welding inserts into the burned away portions of the vanes and the outer shroud band. Figures 85 and 86 show the diaphragm before and after the rework. The bulk of the rework to the static components was to strengthen the pressure and temperature instrumentation for added resistance to thermal stress and subsequent weld-joint leakage. The turbine casing and inlet duct were re-instrumented with new total pressure probes which were changed as shown in Figure 87 . A heavy walled tube is extended out from the turbine duct or casing for about 4 inches where it transitions down to a 1/4 in. O. D. x .028 in. wall tube. The objective is to maintain a high strength tube section extending from the duct wall to a location beyond the region of high temperature, where the transition to a smaller tube section is made to obtain flexibility for thermal growth between the turbine and the glove box. Figure 88 shows the heavy extensions on the inlet duct, and Figure 89 shows the first stage nozzle diaphragm with the heavier .120 inch O. D. x .030 wall static pressure tubing. Figures 90(a) and 90(b) show the top and bottom casing halves with the heavier instrumentation.

3. Bearing Housing Tube Cavity Cover

The bearing housing rework included the replacement of the hydrodynamic seal and a tube cavity cover discussed above. The sheet metal tube cover was replaced with a new one incorporating a bellows at its aft end as shown installed on the bearing housing in Figure 91. The prior design was a sheet metal cylinder welded at both ends to the bearing housing and containing a single convolution at the forward end, where the crack had occurred during the previous testing.

4. Turbine Assembly

Following rework, the turbine was assembled to the same configuration as the previous potassium testing (Figure 92). Figures 93 (a) and 93 (b) show the fore-and-aft quarter views of the completed turbine assembly prior to installation in the test facility.

The turbine is presently being installed and prepared for resumption of potassium testing.

IV TEST FACILITY

Design work was completed on modifications and repairs to the boiler, which had developed a leak during testing in the previous quarter. All necessary material has been procured and the work of modifying the facility is about 80% complete.

Repairs and modifications to the boiler and facility include the following:

1. Repair welding of two cracked areas in the girth seams of the vapor drum.
2. Visual and radiographic inspection of all boiler welds.
3. Installation of a secondary separator on the boiler drum.
4. Installation of electrical heaters on the boiler drum.
5. Installation of a pre-heated condensate feed system.
6. Condenser modifications to permit higher temperature condensate.
7. Addition of a J-tube liquid level indicator to the boiler drum.
8. Addition of larger surface area micro-filters in the argon extraction and slinger seal argon reclamation systems.

The design and fabrication of all new boiler component appurtenances have been performed in accordance with ASME and State of Ohio Power Boiler Code requirements, and all welds have passed radiographic and helium mass spectrometer leak inspections.

The secondary separator supplements the existing baffle plate and demister arrangement in the vapor drum to minimize liquid potassium carryover into the 8 inch discharge nozzle. It consists of a vertical drum containing a baffle-type cylindrical separator and is mounted on the top center of the vapor drum. The 8 inch discharge nozzle is extended approximately 30 inches vertically into the separator and receives the dry vapor after it passes through the baffled cylinder. Entrained liquid is drained back to the lower drum.

Approximately 30 kilowatts of variac-controlled electrical resistance heaters are being mounted above the vapor drum to permit more uniform heatup-and cool-down of the drum.

A new condensate feed system has been installed. A preheat coil increases the condensate temperature about 200°F before it enters the boiler. The feed liquid is injected directly into each of the four downcomers to enhance the natural recirculation characteristics of the boiler.

A J-tube liquid level indicator has been added to supplement the existing nuclear level gage and will permit a faster readout of that variable.

Condenser cooling air flow has been redirected by the addition of baffles and will be controlled by the operation of new louver dampers in the induction fan inlet duct. This will permit better control of the condensate temperature as it leaves the condenser.

Other modifications include the addition of larger surface area microfilters in both the argon extraction and argon reclamation systems, which will minimize downtime due to possible plugging of filters in these systems. Also, about 30 feet of slinger seal argon reclamation system piping has been increased in size from 3/4 inch diameter to 1 inch diameter pipe, thereby reducing the turbine hydrodynamic seal cavity pressure (P8) and increasing the margin of safety against buffer seal breakdown.

The discharge from the throttling calorimeter has been rerouted to discharge directly to the condenser, so that it will no longer result in an apparent reversal of flow through the heating calorimeter at the turbine discharge.

A new Taylor pressure gage has been installed at instrumentation Station 1, another will be added at Station 7 when the turbine is reinstalled. The existing Taylor gage at Station 8 will be replaced.

V MATERIALS SUPPORT

A. TURBINE EROSION AND CORROSION

A preliminary evaluation has been made to this date of the metal loss observed on first and second stage turbine buckets. A typical example of the appearance of a first stage turbine bucket after test is shown in Figure 94. Metal loss from the second stage buckets was much less severe than this. While the exact cuases and precise conditions influencing this metal loss are not yet known, the deterioration of the buckets is undoubtedly due to the presence of liquid potassium in the vapor flow. It was inferred from examination of the buckets, (1) that a large amount of liquid metal must have been involved and, (2) based on the lesser damage to the second stage, liquid metal was both dispersed into finer droplets by the action of the first stage buckets, and perhaps, rendered less corrosive or erosive in the second stage.

By examination of the turbine component parts it was reasonably inferred that flow of liquid metal occurred in the following manner:

> Liquid potassium droplets either carried in the vapor from the boiler or injected into the 8 inch diameter vapor line at the spray nozzle were collected on the bullet nose and flowed through the first stage nozzle partition along the inner band. Other liquid potassium

droplets which did not collect on the bullet nose passed directly through the nozzle diaphragm; some of these larger droplets collected on the nozzle partitions and left the trailing edge of the partitions as slow moving droplets which were subsequently struck by the convex side of the leading edge of the first stage buckets.

Where the liquid metal flowed over the inner band of the nozzle diaphragm, a stream of liquid (or drops) struck the face of the wheel at the bucket dovetail. Liquid impacting against the bucket dovetail flowed under the bucket platform and resulted in the formation of a severe groove in the bucket immediately under the platform at the leading edge of the bucket. Liquid under the platform was forced between the edges of the platforms of adjacent buckets by centrifugal force. A grooving type of metal removal occurred on the bucket platforms at this point. The liquid then flowed radially along the convex surface of the adjacent bucket.

Droplets which struck the convex side of the turbine bucket airfoil appeared to have flowed either forward and off the leading edge of the bucket or toward the rear of the bucket depending upon the location of the strike. It is believed that forward liquid flow occurred in the area of rivulations and that the smooth area immediately aft of it indicates an area in which impact was practically normal to the surface. A radial line of pits on the convex side of the bucket marks the point at which the high liquid contacting forces produced by the impacting droplets no longer existed; from the line of pits aft evidences of radial liquid flow on the convex surface was noticed.

Liquid flowing over the tip of the bucket resulted in a rounding and grooving of the convex side of the bucket and the formation of a small metallic fin on the concave side of the bucket at its tip. Other metallic deposits occurred as thin films on the concave side of the bucket aft of the mid-chord position.

The metal loss from the buckets, described in the above discussion of liquid flow, may have occurred from one or more processes. While certain hypothesis can now be made as to suspected methods of metal removal, the actual proof of a selected erosion mechanism must await extensive study. There are, however, several types of erosion which have been observed in steam turbine operation and in other applications which merit consideration.

Impact erosion has been observed in steam turbines and is believed to be the result of mechanical damage produced by droplet impact and flow. The most significant erosion of this type occurs on the convex side of bucket leading edges. In hard erosion shields, the metal loss occurs as needle-like pits and is accompanied by microcracks at the base of the pits. Washing erosion is another type of metal removal caused by the continuous flow of liquid over a surface; the mechanism of erosion is not known but may involve wear or solution corrosion. Wire drawing is a similar form of smooth erosion which occurs when a fluid flows through a small constriction under a high pressure differential; again the mechanism is not known but may involve wear or solution corrosion. Direct solution corrosion in liquid metals is always a possibility; it involves the chemical dissolution of the metal component part in the alkali metal in an attempt to satisfy the solubility of the liquid for the solute elements comprising the part. At high droplet impacting pressures or under the influence of cavitation liquid boundary layer films can be very thin and this mechanism of metal removal may be more severe under such conditions than the solution corrosion noted in pumped liquid metal loops.

With the above as background it is suggested that the solution corrosion mechanism was probably most significant in the removal of metal from the buckets. The formation of metal fins and films on the bucket also suggests that metal transport occurred through a solution mechanism. Nevertheless, any statements regarding the mechanism of erosion must presently be regarded as hypothesis rather than as proven fact. Additional turbine operating experience, fundamental erosion studies and more detailed evaluation of existing components are necessary to a more complete appreciation of the possible erosion problem in alkali metal turbines.

Smaller amounts of corrosion and/or erosion, compared to the first stage buckets, occurred (1) on the Type 316 stainless steel inner and outer duct shrouds around each first stage nozzle partition, and (2) along the leading edge of the L-605 partitions themselves. The pattern of metal loss in the Type 316 stainless steel duct walls appeared to trace the fluid flow path around each partition. Erosion and/or corrosion is more evident on the leading edges than elsewhere on the L-605 partitions, illustrating the influence of droplet impact and flow effects.

A first stage turbine bucket was sectioned in several places and metallographically examined to determine, if possible, the nature of the metal removal process and the nature and extent of any subsurface metallographic changes in the U-700 microstructure produced by exposure to potassium vapor. Several photomicrographs were made of the bucket edges and are shown in relation to their location on the bucket in Figure 94.

It should be observed that while local attack has occurred at various places on the bucket, the attack is not preferential with respect to the U-700 microstructure; this is evidenced by absence of preferential attack of either grains or grain boundaries. No subsurface microstructural changes or diffusion zones were determinable; microhardness traverses from the bucket edge inward showed no variation in hardness. Furthermore, the turbine bucket hardness, itself, had not changed as a result of being exposed to the hot potassium vapor.

B. INSTRUMENTATION LINES

In order to increase the reliability of the thermocouple and efflux lines, the original lines were replaced with larger diameter, heavy walled tubing; the increase in diameter, accompanied by modifications in joint configuration and joint location, is expected to improve the resistance of the instrumentation to failure by thermal and fatigue stresses.

The welds joining the efflux and thermocouple lines to the facility were radiographed for soundness and areas in question were repaired. The tube assemblies were all helium leaktight.

C. REFRACTORY METAL PROBE

A request was made by NASA to insert refractory metal specimens into the eight inch vapor line for the purpose of determining their erosion resistance and contamination during operation of the turbine facility. A concept was developed for installing ring type refractory alloy specimens on a 316 stainless steel probe inserted into the eight inch vapor line at station #1. Samples of F48, AS-30 and TZM will be prepared for installation on the probe. Results of these tests will be given in following reports.

D. DUMP TANK POTASSIUM ANALYSIS

A summary of the oxygen and carbon analyses of the potassium in the 3000 KW 1000 dump tank initiation of turbine testing is given in Table XVI.

TABLE I

TOD COMPUTER PROGRAM INPUT VALUES

Quantity	Stage 1 Value	Stage 2 Value
Nozzle Exit Angle (Pitch), Degree	71.25	72.5
Bucket Inlet Angle (Pitch), Degree	59.0	54.85
Bucket Exit Angle (Pitch), Degree	64.6	62.25
Nozzle Inlet Angle (Pitch), Degree	27.44	24.07
Nozzle Leading Edge Pitch Diameter, Inches	7.575	8.246
Nozzle Trailing Edge Pitch Diameter, Inches	8.078	8.677
Bucket Leading Edge Pitch Diameter, Inches	8.087	8.675
Bucket Trailing Edge Pitch Diameter, Inches	8.120	8.713
Nozzle Leading Edge Hub Diameter, Inches	6.980	7.446
Nozzle Trailing Edge Pitch Diameter, Inches	7.316	7.674
Nozzle Leading Edge Hub Diameter, Inches	6.980	7.446
Nozzle Trailing Edge Pitch Diameter, Inches	7.316	7.674
Bucket Leading Edge Hub Diameter, Inches	7.344	7.700
Bucket Trailing Edge Hub Diameter, Inches	7.410	7.776
Nozzle Efficiency	.936	.902
Bucket Efficiency	.742	.769
Nozzle Flow Coefficient	1.00	1.00
Bucket Flow Coefficient	.8301	.7522
Number of Nozzle Blades	38.0	46.0
Number of Bucket Blades	62.0	60.0

TABLE II

COMPARISON OF RESULTS OF DESIGN AND OFF DESIGN PROGRAMS AT APPROXIMATELY DESIGN FLOW CONDITIONS

QUANTITY	First Stage		Second Stage	
	TEP	TOD	TEP	TOD
Inlet Total Temperature, °F	1600	1600	1499	1499
Inlet Total Pressure, psia.	38.24	38.24	24.6	24.6
Inlet Vapor Quality	.92	.92	.89	.89
Dry Vapor Flow, pps.	2.67	2.67	2.59	2.59
Rotative Speed, rpm.	19200	19200	19200	19200
Specific Work, Btu/lb.$_m$	30.65	30.65	43.0	43.0
Nozzle Exit Angle, deg.	70.85	70.85	72.0	72.0
Bucket Inlet Flow Angle, deg.	37.3	37.2	39.6	39.7
Bucket Exit Angle, deg.	64.5	64.6	63.7	62.2
Stage Exit Flow Angle, deg.	26.3	29.8	39.0	37.1
Total to Total Efficiency (no droplet drag loss)	.805	.782	.796	.752
Total to Static Efficiency (no droplet drag loss)	.722	.715	.657	.606
Bucket Inlet Pitch dia., in.	8.09	8.09	8.68	8.68
Bucket Inlet Blade Length, in.	.744	.743	1.03	.98
Reaction at Hub	.44	.445	.55	.56
Reaction at Pitch	.52	.53	.63	.65
Bucket Inlet Axial Velocity, fps.	320.	320.	323.	323.
Bucket Exit Pitch dia., in.	8.13	8.12	8.72	8.71
Bucket Exit Blade Length, in.	.715	.71	.98	.94
Bucket Exit Axial Velocity, fps.	424.	423.	600.	638.
Nozzle Total to Static Pressure Ratio	1.248	1.247	1.322	1.321
Stage Total to Static Pressure Ratio	1.615	1.625	2.24	2.42
Stage Total to Total Pressure Ratio	1.535	1.555	1.922	2.005
Pitch Velocity Ratio, $\bar{u}/v_o$	.466	.463	.402	.386
Overall Total to Total Efficiency (Supersaturated Flow, no moisture)			.807	.792
Bucket Tip Clearance (Running), in.	.05	.05	.05	.05

NOTE: All angles referenced from axial

TABLE III

TARE TORQUE DATA

Test Date	Rotative Speed,	Water Brake Bearing & Seal Flow	Hydrodynamic Seal K Flow	Seal Exit Temp.	Seal Temp. Rise	Facility Pressure	K Turbine Torque Reading Manual	K Turbine Torque Reading Digital	Steam Turbine Torque Meter Manual	Steam Turbine Torque Meter Digital	Corrected Steam Turbine Torque
	N	Q_w	Q_k	T_{kin}	ΔT_k	P_f	Q_{km}	Q_{kd}	Q_{sm}	Q_{sd}	Q_{sc}
	rpm	gpm	gpm	°F	°F	psia	in-lb	in-lb	in-lb	in-lb	in-lb
4-11-64	6,550	1.0	--	242	--	20.0			63		68
	10,650		.69	285	100	18.5			102		111
	14,720		1.25	345	187	16.5			140		152
	14,690		1.50	349	145	9.5			125		136
	14,720			335	164	9.0			122		132
	14,720			344	164	6.6			115		125
	14,700		2.05	333	129	6.0			116		126
	16,430			350	175	6.0			145		157
	17,140			356	182	5.5			150		163
	14,730			338	130	2.2			117		127
6-24-64	3,100	1.0	0	--	--	--			5		
	8,220								14		
	15,130								18		
	20,110								24		
	9,470	10.0							38		
	15,000								40		
	20,010								50		
	19,740	12.7							85		
6-30-64	9,150	2.0	0	--	--	--			18		
	11,970								20		
	15,260								22		
	18,080								24		
	18,900								26		
	19,500								25		
	19,920								26		
	20,540								28		
	20,000								26		
	19,450	11.5							56		
9-28-64	15,302	1.0	1.0			5.8		59.2	96.0	99.1	
	16,133					2.4		61.3	96.0	99.1	
	15,983					2.0		61.9	94.0	97.2	
	17,009					1.8		63.5	100.0	103.6	

TABLE III - (Cont'd)

TARE TORQUE DATA

Test Date	Rotative Speed,	Water Brake Bearing & Seal Flow	Hydrodynamic Seal K Flow	Seal Exit Temp.	Seal Temp. Rise	Facility Pressure	K Turbine Torque Reading Manual	K Turbine Torque Reading Digital	Steam Turbine Torque Meter Manual	Steam Turbine Torque Meter Digital	Corrected Steam Turbine Torque
	N	Q_w	Q_k	T_{kin}	ΔT_k	P_f	Q_{km}	Q_{kd}	Q_{sm}	Q_{sd}	Q_{sc}
	rpm	gpm	gpm	°F	°F	psia	in-lb	in-lb	in-lb	in-lb	in-lb
10-2-64	16,028	1.0	1.0	--	--	3.6		41.1		123.3	
	16,061					3.3		42.1		123.0	
	16,167					3.3		42.4		121.5	
	16,106					2.9		41.2		121.2	
10-8-64	12,190	1.0	1.0			16.0			106.0		115.3
	14,290					13.5			117.0		127.1
	14,940					10.0			116.0		126.1
	15,000					8.0			112.0		121.7
	14,980					6.2			110.0		119.6
	16,260					5.5			116.0		126.1
12-14-64	5,020	1.0	0			--		5.0	9.0	9.7	
	9,950							9.8	14.0	15.2	
	14,060							13.5	16.1	17.9	
	16,000							15.8	18.2	19.7	
	17,990							20.8	20.2	22.4	
	20,040							21.7	21.2	23.4	
	10,100							14.9	13.2	14.3	
	5,050	1.75	0			--		7.5	9.5	10.8	
	10,000							12.7	15.5	17.6	
	13,990							17.7	19.6	21.4	
	16,000							19.6	21.6	23.6	
	17,990							23.7	24.2	26.6	
	19,960							27.1	26.7	27.1	
	5,010	1.0	0			--		6.0	8.9	9.8	
	9,980							12.5	16.4	18.0	
	14,030							15.5	20.0	21.4	
	16,040							18.1	21.0	23.4	
	17,990							20.8	22.6	24.7	
	19,980							23.3	24.1	26.3	

TABLE IV

POTASSIUM TURBINE BEARING TEST

Test Date, August 17, 1963

Rotative Speed, rpm	Pad Bearing Flow Q_{pb} gpm	Ball Bearing Flow Q_{bb} gpm	Lube Inlet Temperature T_{in} °F	Lube Outlet Temperature T_{out} °F	Power, HP
5,110	2.198	.756	126	131	1.5
11,070	2.153	.765	127	142	5.8
15,080	2.198	.773	128	153	10.8
20,410	2.107	.773	129	171	19.9
23,150	2.061	.782	129	179	23.7
4,930	2.244	.833	151	152	1.0
10,950	2.198	.833	152	162	5.0
16,100	2.153	.825	149	172	11.1
20,500	2.107	.842	149	184	19.5
4,680	4.305	.799	153	156	1.1
10,900	4.030	.790	152	162	5.5
16,000	3.756	.799	153	171	11.7
4,730	4.259	.825	170	171	0.9
10,950	3.939	.816	170	179	5.0
16,380	3.664	.833	173	188	11.3

TABLE V

FLOW CALCULATED USING BULLET NOSE ΔP MEASUREMENT

1450°F Inlet Temperature

Point	P_{T3} Avg.	$v_{sat}\ T_3$	$P_{T3}-P_{S3}$	X_3W	X_3	W	W_{EMFM}	Corr. W_{EMFM}
1-2	21.46	22.7	.60	1.51	1.0	1.51	1.71	--
1-4	21.87	22.3	.605	1.534	1.0	1.534	1.703	--
2-3	21.66	22.5	.585	1.50	1.0	1.50	1.701	1.52
3-1	21.66	22.5	.60	1.521	1.0	1.521	1.549	--
3-3	21.74	22.4	.57	1.484	1.0	1.484	1.552	--
4-1	19.4	24.9	.48	1.293	1.0	1.293	1.581	--
4-3	21.07	23.0	.48	1.346	1.0	1.346	1.504	--
137-1	21.52	22.6	.606	1.524	1.0	1.524	1.697	1.47
137-4	21.88	22.3	.603	1.53	1.0	1.53	1.679	1.46
138-1	20.53	23.5	.54	1.413	1.0	1.413	1.614	--
138-2	20.86	23.2	.54	1.421	1.0	1.421	1.608	--
138-4	21.33	22.8	.54	1.432	1.0	1.432	1.605	--
7-2	21.59	22.6	.57	1.477	.978	1.511	1.698	1.48
7-3	21.89	22.3	.60	1.526	.961	1.588	1.722	1.50
8-1	21.55	22.6	.53	1.425	.944	1.51	1.757	1.98
8-2	21.77	22.3	.54	1.448	.936	1.547	1.752	1.98
8-3	21.28	22.8	.53	1.419	.937	1.515	1.76	1.98
8-4	21.18	23.0	.53	1.414	.955	1.482	1.762	1.98
9-1	21.14	23.0	.54	1.427	.881	1.62	2.104	1.66
9-2	21.42	22.7	.51	1.396	.866	1.612	2.009	1.56
9-3	20.86	23.2	.51	1.381	.867	1.594	2.0	1.55
19-2	23.2	21.1	.72	1.718	.866	1.984	1.942	--
19-3	22.88	21.4	.74	1.731	.865	2.0	1.943	--
29-1	22.97	21.3	.80	1.804	.845	2.135	2.328	1.97
29-2	23.15	21.1	.83	1.846	.849	2.175	2.311	1.96
29-3	23.34	21.0	.80	1.817	.851	2.137	2.286	1.93
28-1	22.22	22.0	.78	1.754	.916	1.915	1.851	2.21
-2	22.29	22.0	.87	1.85	.918	2.015	1.854	2.21
-3	22.27	22.0	.81	1.786	.911	1.961	1.846	2.20
-4	22.63	21.6	.77	1.758	.909	1.935	1.847	2.20
39-1	22.16	22.0	.81	1.786	.851	2.10	2.293	1.85
-2	22.05	22.1	.75	1.714	.853	2.01	2.323	1.88
-3	22.24	22.0	.81	1.785	.863	2.07	2.456	2.01
-4	21.95	22.2	.81	1.778	.851	2.09	2.374	1.93

TABLE V - (Cont'd)

FLOW CALCULATED USING BULLET NOSE ΔP MEASUREMENT

1550°F Inlet Temperature

Point	P_{T3} Avg.	v_{T3}	ΔP	X_3W	X_3	W	W_{EMFM}
61-1	30.11	16.7	1.26	2.53	.985	2.57	2.413
-2	30.26	16.5	1.23	2.515	.986	2.55	2.398
-3	29.78	16.8	1.23	2.495	.986	2.53	2.39
-4	29.85	16.8	1.23	2.495	.986	2.53	2.34
62-1	29.66	16.8	1.2	2.46	.987	2.49	2.333
-2	29.37	17.1	1.14	2.38	.988	2.41	2.343
-3	29.5	16.9	1.14	2.395	.988	2.425	2.354
-4	29.66	16.8	1.14	2.405	.989	2.433	2.36
63-1	29.62	16.8	1.2	2.46	.989	2.49	2.387
-3	29.87	16.8	1.18	2.44	.989	2.47	2.39
-4	29.48	16.9	1.18	2.435	.991	2.46	2.391
-5	29.73	16.8	1.19	2.45	.99	2.475	2.401
64-1	29.06	17.2	1.17	2.405	.989	2.433	2.408
-4	29.87	16.8	1.16	2.42	.988	2.45	2.406
65-1	29.97	16.7	1.2	2.47	.989	2.50	2.422
-2	30.36	16.4	1.2	2.495	.989	2.525	2.423
-3	30.46	16.4	1.21	2.505	.989	2.535	2.433
-4	30.29	16.5	1.22	2.51	.989	2.54	2.444
67-1	30.34	16.4	1.21	2.505	.946	2.65	2.597
-2	30.22	16.5	1.18	2.465	.966	2.55	2.531
76-1	30.25	16.5	1.2	2.485	.963	2.58	2.435
-2	29.84	16.8	1.2	2.465	.951	2.59	2.449
94-1	28.09	17.7	1.11	2.31	.955	2.42	2.425
-2	27.64	18.0	1.16	2.34	.952	2.46	2.41
68-1	30.65	16.4	1.2	2.495	.923	2.70	2.59
-2	30.96	16.2	1.19	2.495	.933	2.675	2.605
77-1	30.5	16.4	1.23	2.52	.906	2.78	2.515
-2	30.49	16.4	1.24	2.53	.922	2.745	2.499
86-1	29.08	17.2	1.17	2.405	.91	2.645	2.496
-2	29.03	17.2	1.17	2.405	.92	2.615	2.479
69-1	30.36	16.5	1.21	2.495	.852	2.93	2.883
-2	30.84	16.3	1.18	2.48	.843	2.94	2.898
78-1	30.4	16.5	1.2	2.485	.855	2.91	2.813
-2	30.03	16.7	1.18	2.45	.854	2.87	2.806
87-1	29.16	17.1	1.17	2.41	.857	2.81	2.797
-2	28.32	17.6	1.18	2.385	.852	2.80	2.789

TABLE VI

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

Test Dates:	Sept. 29 & 30, 1964
Nominal Inlet Temperature, °F:	1450
Nominal Inlet Quality, Percent:	99
Total to Total Pressure Ratio:	3.520 to 3.754

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

DATE	PT NO	SC	TURBINE INLET TEMP DEG F	SPEED RPM	TOTAL TO TOTAL PRESSURE RATIO	TOTAL TO STATIC PRESSURE RATIO	SUPPLIED VAPOR QUALITY	INLET VAPOR QUALITY
929.64	41	1	1447	14999	3.539	4.602	0.982	0.982
929.64	41	2	1447	14621	3.527	4.497	0.982	0.982
929.64	41	3	1444	15116	3.617	4.639	0.982	0.982
929.64	41	4	1445	14453	3.536	4.668	0.981	0.981
929.64	52	1	1435	16517	6.613	8.489	0.974	0.974
930.64	42	1	1459	17198	3.620	4.725	0.991	0.991
930.64	42	2	1461	17795	3.633	4.656	0.990	0.990
930.64	42	3	1466	17209	3.586	4.643	0.990	0.990
930.64	42	4	1466	17745	3.634	4.682	0.989	0.989
930.64	43	1	1449	18152	3.575	4.654	0.990	0.990
930.64	43	2	1447	18178	3.580	4.603	0.990	0.990
930.64	43	3	1448	18159	3.543	4.514	0.988	0.988
930.64	43	4	1444	18013	3.531	4.406	0.988	0.988
930.64	44	1	1449	18946	3.549	4.529	0.992	0.992
930.64	44	2	1448	18726	3.684	4.759	0.991	0.991
930.64	44	3	1455	19607	3.676	4.734	0.989	0.989
930.64	44	4	1451	19490	3.730	4.612	0.989	0.989
930.64	51	1	1459	15675	3.532	4.749	0.987	0.987
930.64	51	2	1461	16649	3.584	4.716	0.988	0.988
930.64	51	3	1460	16570	3.621	4.765	0.988	0.988
930.64	51	4	1456	15855	3.590	4.694	0.987	0.987
930.64	53	1	1465	18144	3.647	4.777	0.989	0.989
930.64	53	2	1463	18298	3.690	4.704	0.989	0.989
930.64	53	3	1463	17288	3.675	4.785	0.989	0.989
930.64	53	4	1465	17736	3.624	4.700	0.988	0.988
930.64	54	1	1458	19383	3.666	4.696	0.991	0.991
930.64	54	2	1460	18698	3.669	4.743	0.991	0.991
930.64	54	3	1461	18968	3.754	4.756	0.991	0.991
930.64	54	4	1459	19249	3.698	4.750	0.991	0.991
930.64	127	1	1452	15976	3.552	4.833	0.991	0.991
930.64	127	2	1450	15430	3.581	4.760	0.990	0.990
930.64	127	3	1451	16818	3.520	4.664	0.989	0.989
930.64	127	4	1455	16213	3.545	4.641	0.989	0.989
930.64	128	1	1465	19292	3.660	4.703	0.991	0.991
930.64	128	2	1458	19315	3.702	4.769	0.991	0.991
930.64	128	3	1452	19034	3.719	4.623	0.992	0.992
930.64	129	1	1450	16981	3.598	4.665	0.991	0.991
930.64	129	2	1445	16223	3.579	4.703	0.990	0.990
930.64	129	3	1445	16437	3.547	4.634	0.990	0.990
930.64	129	4	1448	16564	3.579	4.622	0.990	0.990

PT NC	SC	EXIT VAPOR QUALITY	SUPPLY TOTAL PRESSURE PSIA	INLET TOTAL PRESSURE PSIA	EXIT TOTAL PRESSURE PSIA	DOWN STREAM TOTAL PRESSURE PSIA	SUPPLY STATIC PRESSURE PSIA
41	1	0.917	21.03	20.92	5.94	4.01	21.01
41	2	0.922	20.73	20.77	5.88	4.00	20.53
41	3	0.918	21.02	20.83	5.81	3.99	20.97
41	4	0.920	21.06	20.94	5.96	4.10	20.99
52	1	0.922	36.96	20.24	5.59	3.61	19.93
42	1	0.924	20.57	20.64	5.68	3.75	20.46
42	2	0.920	21.01	21.08	5.78	3.81	21.00
42	3	0.921	21.49	21.54	5.99	3.92	21.34
42	4	0.918	21.49	21.53	5.91	4.11	21.39
43	1	0.923	19.90	19.89	5.57	4.00	19.77
43	2	0.923	19.59	19.61	5.47	4.10	19.55
43	3	0.924	19.56	19.60	5.52	4.25	19.45
43	4	0.923	19.18	19.13	5.43	4.27	18.78
44	1	0.921	19.63	19.54	5.53	4.14	19.51
44	2	0.926	19.59	19.39	5.32	3.88	19.54
44	3	0.912	20.42	20.36	5.56	3.75	20.34
44	4	0.916	20.08	19.94	5.38	3.68	20.01
51	1	0.923	20.77	20.81	5.88	3.36	20.68
51	2	0.915	20.90	20.95	5.83	3.39	20.83
51	3	0.920	21.03	20.99	5.81	3.41	20.92
51	4	0.922	20.53	20.59	5.72	3.37	20.42
53	1	0.915	21.55	21.56	5.91	3.47	21.44
53	2	0.913	21.41	21.37	5.80	3.47	21.32
53	3	0.919	21.21	21.24	5.77	3.41	21.10
53	4	0.916	21.30	21.34	5.88	3.46	21.23
54	1	0.919	20.72	20.63	5.65	3.39	20.63
54	2	0.924	20.84	20.74	5.68	3.40	20.78
54	3	0.919	21.08	21.01	5.61	3.40	21.01
54	4	0.920	20.96	20.91	5.67	3.40	20.83
127	1	0.928	20.19	20.17	5.68	3.26	20.06
127	2	0.931	20.07	20.08	5.60	3.25	19.99
127	3	0.924	19.94	19.93	5.66	3.52	19.89
127	4	0.927	20.11	20.24	5.67	3.54	20.00
128	1	0.919	21.22	21.30	5.80	3.43	21.12
128	2	0.921	20.86	20.81	5.63	3.39	20.85
128	3	0.925	20.13	20.03	5.41	3.36	20.08
129	1	0.925	19.76	19.80	5.49	3.73	19.69
129	2	0.929	19.55	19.60	5.46	3.76	19.38
129	3	0.928	19.44	19.52	5.48	3.83	19.35
129	4	0.926	19.76	19.75	5.52	3.97	19.67

PT NO	SC	TIP INLET STATIC PRESSURE PSIA	HUB INLET STATIC PRESSURE PSIA	1ST NOZ TIP EXIT STATIC PRESSURE PSIA	1ST NOZ HUB EXIT STATIC PRESSURE PSIA	1ST ROTOR TIP EXIT STATIC PRESSURE PSIA	1ST ROTOR HUB EXIT STATIC PRESSURE PSIA
41	1	20.19	20.13	16.02	14.56	11.56	13.95
41	2	20.10	20.16	16.00	14.38	11.47	13.79
41	3	20.13	20.03	15.81	14.22	11.47	13.77
41	4	20.14	20.12	15.91	14.50	11.60	13.89
52	1	19.34	19.36	15.45	13.89	11.15	13.47
42	1	19.69	19.80	15.65	14.09	11.29	13.53
42	2	20.34	20.43	16.24	14.58	11.62	13.85
42	3	20.39	20.42	16.29	14.62	11.66	14.14
42	4	20.70	20.77	16.57	14.81	11.78	14.09
43	1	18.96	18.98	15.17	13.65	10.87	13.10
43	2	18.81	18.79	14.89	13.28	10.68	12.75
43	3	18.85	18.85	14.99	13.44	10.68	12.86
43	4	18.50	18.49	14.67	13.26	10.60	12.71
44	1	19.14	18.88	15.27	13.75	10.91	13.04
44	2	18.71	18.68	14.77	13.53	10.72	12.82
44	3	19.66	19.70	15.84	14.38	11.23	13.49
44	4	19.08	19.10	15.07	13.46	10.74	12.86
51	1	19.97	19.95	15.74	14.34	11.47	13.83
51	2	20.03	20.03	15.89	14.44	11.58	13.83
51	3	20.03	20.03	15.88	14.34	11.50	13.75
51	4	19.73	19.73	15.57	14.07	11.27	13.59
53	1	20.66	20.68	16.31	14.76	11.78	14.18
53	2	20.45	20.47	16.20	14.58	11.66	13.97
53	3	20.26	20.32	16.12	14.44	11.60	13.87
53	4	20.51	20.60	16.47	14.77	11.78	14.09
54	1	19.52	19.51	15.80	14.03	11.15	13.67
54	2	19.90	19.92	16.02	14.46	11.49	13.77
54	3	20.26	20.16	16.12	14.54	11.56	13.77
54	4	20.08	20.06	15.98	14.32	11.39	13.63
127	1	19.25	19.27	15.11	13.61	10.97	13.30
127	2	19.22	19.18	15.09	13.51	10.89	13.20
127	3	19.28	19.18	15.27	13.87	11.07	13.34
127	4	19.48	19.58	15.47	13.87	11.17	13.40
128	1	20.45	20.43	16.42	15.03	11.82	14.12
128	2	19.89	19.91	15.93	14.28	11.33	13.65
128	3	19.09	19.12	15.21	13.59	10.78	13.22
129	1	19.12	19.09	15.05	13.67	10.89	13.10
129	2	18.75	18.81	14.75	13.36	10.76	12.84
129	3	18.52	18.61	14.62	13.12	10.58	12.69
129	4	18.71	18.76	14.82	13.18	10.64	12.73

PT NO	SC	2ND NOZ HUB EXIT STATIC PRESSURE PSIA	2ND ROTOR HUB EXIT STATIC PRESSURE PSIA	DOWN STREAM STATIC PRESSURE PSIA	DOWN STREAM TAYLOR STATIC PRESSURE PSIA	INLET CALORI-METER PRESSURE PSIA	INLET CALORI-METER TEMP DEG F
41	1	7.01	4.57	3.17	3.42	3.37	1161
41	2	6.89	4.61	3.22	3.43	3.41	1164
41	3	6.80	4.53	3.24	3.47	3.43	1162
41	4	6.97	4.51	3.30	3.44	3.51	1161
52	1	6.70	4.35	2.73	2.97	2.90	1146
42	1	6.78	4.35	2.63	3.14	2.90	1187
42	2	6.99	4.51	2.71	3.20	2.95	1187
42	3	7.25	4.63	2.88	3.34	3.13	1189
42	4	7.15	4.59	3.01	3.47	3.25	1189
43	1	6.66	4.27	2.95	3.45	3.17	1187
43	2	6.42	4.26	3.05	3.55	3.27	1189
43	3	6.48	4.33	3.20	3.69	3.45	1185
43	4	6.42	4.35	3.27	3.73	3.49	1188
44	1	6.68	4.33	3.03	3.65	3.25	1198
44	2	6.46	4.12	2.76	3.24	3.01	1185
44	3	6.93	4.31	2.55	3.35	2.84	1175
44	4	6.44	4.35	2.44	3.25	2.66	1171
51	1	6.95	4.37	2.32	2.74	2.66	1164
51	2	6.99	4.43	2.34	2.77	2.60	1166
51	3	6.88	4.41	2.35	2.75	2.66	1168
51	4	6.80	4.37	2.31	2.73	2.64	1162
53	1	7.19	4.51	2.36	2.81	2.70	1172
53	2	7.05	4.55	2.41	2.78	2.72	1174
53	3	6.99	4.43	2.38	2.78	2.66	1171
53	4	7.13	4.53	2.40	2.78	2.70	1171
54	1	7.05	4.41	2.27	3.12	2.58	1176
54	2	6.97	4.39	2.30	2.91	2.54	1177
54	3	7.03	4.43	2.32	3.10	2.56	1179
54	4	6.89	4.41	2.32	2.98	2.58	1178
127	1	6.54	4.18	2.22	2.61	2.56	1177
127	2	6.50	4.22	2.19	2.69	2.54	1169
127	3	6.70	4.27	2.53	2.99	2.84	1176
127	4	6.70	4.33	2.50	2.89	2.80	1175
128	1	7.23	4.51	2.30	2.93	2.58	1182
128	2	6.91	4.37	2.26	2.99	2.56	1179
128	3	6.64	4.35	2.20	2.81	2.48	1178
129	1	6.56	4.24	2.71	3.06	2.95	1188
129	2	6.46	4.16	2.71	3.11	3.01	1185
129	3	6.32	4.20	2.79	3.24	3.07	1186
129	4	6.38	4.27	2.93	3.30	3.23	1188

PT NO	SC	EXIT TEMP DEG F	1ST STAGE HUB REACTION	1ST STAGE TIP REACTION	2ND STAGE HUB REACTION	MAIN TORQUE READING IN-LB	SECONDARY TORQUE READING IN-LB
41	1	1123	0.101	0.532	0.332	612.8	2.7
41	2	1127	0.100	0.550	0.322	594.0	2.5
41	3	1125	0.074	0.517	0.315	600.3	3.7
41	4	1124	0.100	0.517	0.334	602.8	3.5
52	1	1104	0.028	0.253	0.230	531.4	2.5
42	1	1125	0.092	0.532	0.339	532.3	30.0
42	2	1126	0.119	0.553	0.343	527.3	21.4
42	3	1133	0.076	0.534	0.347	533.0	20.7
42	4	1134	0.116	0.555	0.345	530.8	19.9
43	1	1127	0.096	0.538	0.342	506.2	31.2
43	2	1131	0.092	0.536	0.325	505.3	32.1
43	3	1132	0.100	0.548	0.322	483.8	28.2
43	4	1134	0.100	0.535	0.317	496.4	29.6
44	1	1129	0.126	0.560	0.342	486.3	28.5
44	2	1126	0.123	0.519	0.344	447.3	31.1
44	3	1114	0.149	0.563	0.364	493.0	28.1
44	4	1109	0.098	0.529	0.314	480.9	26.9
51	1	1120	0.087	0.521	0.349	545.3	1.1
51	2	1118	0.101	0.523	0.347	565.7	1.8
51	3	1115	0.096	0.522	0.336	555.6	0.8
51	4	1115	0.080	0.527	0.338	549.8	2.6
53	1	1122	0.091	0.526	0.353	583.4	65.1
53	2	1121	0.097	0.529	0.339	589.7	66.6
53	3	1123	0.092	0.533	0.347	591.1	67.6
53	4	1120	0.112	0.554	0.349	584.4	66.7
54	1	1122	0.060	0.549	0.358	517.3	55.3
54	2	1119	0.114	0.546	0.351	514.1	65.5
54	3	1118	0.124	0.541	0.355	548.5	69.1
54	4	1116	0.111	0.542	0.344	543.1	73.2
127	1	1110	0.054	0.512	0.332	558.7	1.8
127	2	1110	0.054	0.521	0.327	541.4	1.0
127	3	1117	0.094	0.534	0.343	539.9	0.9
127	4	1120	0.083	0.542	0.337	533.5	0.5
128	1	1121	0.148	0.550	0.362	541.6	74.1
128	2	1115	0.103	0.546	0.349	537.8	82.2
128	3	1109	0.064	0.539	0.330	544.2	87.9
129	1	1115	0.101	0.531	0.338	510.3	4.9
129	2	1117	0.090	0.516	0.339	517.6	7.5
129	3	1117	0.076	0.519	0.320	515.2	12.6
129	4	1120	0.077	0.523	0.316	521.4	1.5

PT NO	SC	TARE TORQUE READING IN-LB	TOTAL TORQUE READING IN-LB	EMFM FLOW PPS	SPRAY FLOW PPS	TURBINE IDEAL DROP BTU/LB	TURBINE WORK BTU/LB
41	1	75.7	685.8	1.666	0.010	101.0	69.2
41	2	73.6	665.0	1.672	0.015	100.7	65.2
41	3	76.4	672.9	1.674	0.021	102.5	68.1
41	4	72.6	671.9	1.664	0.011	100.8	65.5
52	1	84.3	613.2	1.753	0.014	148.4	64.8
42	1	88.5	590.8	1.615	0.016	103.4	70.6
42	2	92.9	598.8	1.617	0.030	103.7	73.9
42	3	88.6	600.9	1.607	0.017	102.9	72.2
42	4	92.5	603.5	1.614	0.017	103.7	74.4
43	1	95.5	570.5	1.638	0.017	102.1	70.9
43	2	95.7	568.9	1.641	0.017	102.1	70.7
43	3	95.6	551.1	1.640	0.013	101.2	68.4
43	4	94.5	561.3	1.643	0.013	100.8	69.0
44	1	101.4	559.2	1.604	0.010	101.7	74.1
44	2	99.8	516.0	1.579	0.010	104.2	68.6
44	3	106.3	571.2	1.584	0.012	104.2	79.3
44	4	105.4	559.5	1.591	0.010	105.2	76.9
51	1	79.5	623.8	1.596	0.012	101.3	68.7
51	2	85.0	649.0	1.596	0.012	102.5	75.9
51	3	84.6	639.4	1.654	0.025	103.2	71.8
51	4	80.5	627.8	1.606	0.007	102.4	69.5
53	1	95.5	613.8	1.625	0.013	104.0	76.9
53	2	96.6	619.7	1.625	0.016	104.8	78.2
53	3	89.1	612.6	1.617	0.017	104.4	73.4
53	4	92.5	610.1	1.603	0.010	103.4	75.7
54	1	104.6	566.6	1.646	0.025	104.3	74.8
54	2	99.6	548.2	1.620	0.011	104.4	71.0
54	3	101.6	581.0	1.632	0.015	106.2	75.7
54	4	103.6	573.6	1.673	0.047	105.0	74.0
127	1	81.2	638.1	1.692	0.020	101.9	67.6
127	2	78.1	618.5	1.687	0.011	102.3	63.5
127	3	86.0	625.0	1.695	0.011	101.0	69.5
127	4	82.6	615.5	1.685	0.007	101.5	66.4
128	1	104.0	571.5	1.639	0.010	104.4	75.4
128	2	104.1	559.7	1.650	0.012	105.1	73.5
128	3	102.1	558.4	1.668	0.021	105.3	71.4
129	1	86.9	592.3	1.613	0.012	102.7	69.9
129	2	82.6	592.6	1.628	0.015	102.1	66.2
129	3	83.8	586.4	1.619	0.008	101.4	66.8
129	4	84.5	604.5	1.645	0.018	102.1	68.2

PT NO	SC	POWER OUTPUT HP	POWER OUTPUT KW	CORRECTED SPEED RPM	CORRECTED TURBINE WORK BTU/LB	CORRECTED POWER KW	CORRECTED POWER HP
41	1	163	121	15224	71.3	238	319
41	2	154	115	14839	67.2	225	302
41	3	161	120	15351	70.3	239	320
41	4	154	114	14677	67.5	227	305
52	1	160	119	16821	67.2	250	335
42	1	161	120	17393	72.2	220	295
42	2	169	126	17990	75.5	228	306
42	3	164	122	17386	73.7	216	290
42	4	169	126	17931	76.0	225	301
43	1	164	122	18393	72.8	236	316
43	2	164	122	18425	72.6	237	318
43	3	158	118	18410	70.3	230	308
43	4	160	119	18273	71.0	237	317
44	1	168	125	19192	76.0	241	324
44	2	153	114	18975	70.5	221	296
44	3	177	132	19851	81.3	248	333
44	4	173	129	19742	78.9	245	329
51	1	155	115	15860	70.3	212	284
51	2	171	127	16839	77.7	232	311
51	3	168	125	16763	73.5	229	307
51	4	157	117	16052	71.2	219	294
53	1	176	131	18337	78.5	234	314
53	2	179	134	18498	79.9	241	323
53	3	168	125	17478	75.0	225	302
53	4	171	128	17924	77.3	227	305
54	1	174	129	19606	76.5	239	320
54	2	162	121	18908	72.6	221	297
54	3	174	130	19174	77.4	236	316
54	4	175	130	19466	75.7	239	320
127	1	161	120	16176	69.3	228	306
127	2	151	112	15632	65.1	216	290
127	3	166	124	17035	71.3	237	317
127	4	158	118	16413	68.0	221	296
128	1	174	130	19488	77.0	231	310
128	2	171	127	19536	75.1	235	316
128	3	168	125	19270	73.2	238	320
129	1	159	119	17200	71.8	228	306
129	2	152	113	16448	68.1	223	299
129	3	152	114	16664	68.6	223	300
129	4	158	118	16787	70.1	229	307

PT NC	SC	CORRECTED FLOW PPS	1ST STAGE WORK BTU/LB	2ND STAGE WORK BTU/LB	1ST STAGE PERCENT WORK	2ND STAGE PERCENT WORK	TOTAL TO TOTAL EFFICIENCY
41	1	3.167	18.2	51.1	26.22	73.78	0.686
41	2	3.182	17.7	47.5	27.14	72.86	0.648
41	3	3.226	18.2	50.0	26.64	73.36	0.665
41	4	3.195	17.1	48.3	26.19	73.81	0.649
52	1	3.533	15.8	49.0	24.35	75.65	0.437
42	1	2.895	18.8	51.8	26.62	73.38	0.683
42	2	2.864	20.2	53.7	27.34	72.66	0.713
42	3	2.788	18.9	53.2	26.24	73.76	0.702
42	4	2.808	20.3	54.1	27.35	72.65	0.717
43	1	3.073	18.7	52.2	26.37	73.63	0.694
43	2	3.105	19.6	51.1	27.67	72.33	0.692
43	3	3.101	18.8	49.6	27.47	72.53	0.677
43	4	3.163	18.9	50.1	27.38	72.62	0.684
44	1	3.017	19.8	54.3	26.72	73.28	0.728
44	2	2.976	18.0	50.6	26.27	73.73	0.658
44	3	2.900	21.1	58.2	26.61	73.39	0.761
44	4	2.955	21.8	55.1	28.35	71.65	0.731
51	1	2.857	17.6	51.1	25.61	74.39	0.678
51	2	2.835	19.9	56.0	26.20	73.80	0.741
51	3	2.956	18.9	52.9	26.38	73.62	0.696
51	4	2.921	18.2	51.3	26.20	73.80	0.679
53	1	2.834	20.3	56.5	26.42	73.58	0.739
53	2	2.857	21.2	57.0	27.07	72.93	0.746
53	3	2.847	19.6	53.9	26.65	73.35	0.703
53	4	2.793	20.2	55.4	26.73	73.27	0.732
54	1	2.960	19.0	55.8	25.43	74.57	0.717
54	2	2.895	18.4	52.6	25.87	74.13	0.679
54	3	2.892	20.2	55.5	26.74	73.26	0.713
54	4	2.995	20.0	53.9	27.09	72.91	0.704
127	1	3.131	17.4	50.2	25.71	74.29	0.663
127	2	3.148	16.5	47.0	26.00	74.00	0.621
127	3	3.148	17.9	51.7	25.68	74.32	0.689
127	4	3.081	17.7	48.7	26.61	73.39	0.654
128	1	2.856	19.6	55.8	26.00	74.00	0.722
128	2	2.972	19.4	54.1	26.41	73.59	0.699
128	3	3.089	18.8	52.6	26.36	73.64	0.679
129	1	3.016	18.5	51.4	26.49	73.51	0.681
129	2	3.108	17.7	48.6	26.70	73.30	0.649
129	3	3.090	18.1	48.6	27.15	72.85	0.658
129	4	3.103	18.9	49.3	27.71	72.29	0.668

PT NO	SC	TOTAL TO STATIC EFFICIENCY	TURBINE VELOCITY RATIO	EXPANSION EXPONENT
41	1	0.579	0.225	1.453
41	2	0.553	0.221	1.453
41	3	0.567	0.226	1.452
41	4	0.544	0.216	1.451
52	1	0.393	0.211	1.444
42	1	0.577	0.255	1.463
42	2	0.609	0.265	1.462
42	3	0.595	0.256	1.461
42	4	0.611	0.264	1.460
43	1	0.587	0.271	1.461
43	2	0.589	0.272	1.462
43	3	0.578	0.274	1.459
43	4	0.592	0.274	1.460
44	1	0.622	0.285	1.464
44	2	0.561	0.278	1.462
44	3	0.649	0.291	1.460
44	4	0.639	0.292	1.461
51	1	0.562	0.232	1.458
51	2	0.623	0.247	1.459
51	3	0.585	0.245	1.459
51	4	0.573	0.236	1.458
53	1	0.624	0.268	1.459
53	2	0.641	0.272	1.460
53	3	0.596	0.256	1.460
53	4	0.621	0.263	1.459
54	1	0.614	0.288	1.462
54	2	0.579	0.277	1.462
54	3	0.616	0.281	1.462
54	4	0.603	0.285	1.462
127	1	0.546	0.236	1.463
127	2	0.518	0.229	1.461
127	3	0.575	0.251	1.461
127	4	0.550	0.242	1.461
128	1	0.617	0.286	1.463
128	2	0.597	0.286	1.463
128	3	0.592	0.284	1.464
129	1	0.578	0.253	1.463
129	2	0.545	0.241	1.462
129	3	0.555	0.246	1.462
129	4	0.567	0.248	1.462

TABLE VI (Cont'd)

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

Test Dates:	Sept. 30, Oct. 2 & 4, 1964
Nominal Inlet Temperature, °F:	1450
Nominal Inlet Quality, Percent:	85, 92, 95, 99
Total to Total Pressure Ratio:	3.193 to 3.886

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

DATE	PT NO	SC	TURBINE INLET TEMP DEG F	SPEED RPM	TOTAL TO TOTAL PRESSURE RATIO	TOTAL TO STATIC PRESSURE RATIO	SUPPLIED VAPOR QUALITY	INLET VAPOR QUALITY
930.64	130	1	1447	19670	3.667	4.714	0.989	0.989
930.64	130	2	1447	19704	3.669	4.647	0.989	0.989
930.64	130	3	1455	20086	3.637	4.610	0.989	0.989
1002.64	49	1	1476	19334	3.436	4.498	0.978	0.834
1002.64	49	2	1478	18791	3.385	4.560	0.979	0.847
1002.64	49	3	1479	19376	3.454	4.519	0.978	0.848
1002.64	49	4	1479	17759	3.433	4.549	0.978	0.846
1002.64	57	1	1465	20386	3.379	4.530	0.985	0.955
1002.64	57	2	1458	19429	3.320	4.670	0.984	0.956
1002.64	57	3	1452	19816	3.365	4.743	0.989	0.958
1002.64	57	4	1447	19048	3.301	4.731	0.990	0.960
1002.64	58	1	1430	19451	3.375	4.891	0.998	0.941
1002.64	58	2	1443	18738	3.353	4.599	0.990	0.924
1002.64	58	3	1458	18163	3.427	4.673	0.989	0.924
1002.64	58	4	1453	20000	3.341	4.693	0.989	0.927
1002.64	59	1	1463	17499	3.349	4.668	0.988	0.859
1002.64	59	2	1458	18329	3.193	4.520	0.987	0.863
1002.64	59	3	1456	19349	3.343	4.638	0.988	0.855
1002.64	59	4	1460	17995	3.274	4.598	0.988	0.853
1004.64	47	1	1471	18583	3.814	4.550	0.992	0.959
1004.64	47	2	1474	19061	3.766	4.489	0.991	0.954
1004.64	47	3	1474	17934	3.843	4.563	0.991	0.965
1004.64	47	4	1471	19013	3.755	4.655	0.990	0.959
1004.64	48	1	1474	17999	3.824	4.679	0.988	0.922
1004.64	48	2	1472	19454	3.539	4.260	0.988	0.911
1004.64	48	3	1469	19035	3.772	4.615	0.989	0.922
1004.64	48	4	1471	18622	3.721	4.619	0.991	0.927
1004.64	48	5	1473	17561	3.688	4.429	0.990	0.922
1004.64	31	1	1476	14181	3.540	4.386	0.985	0.985
1004.64	32	1	1454	17536	3.690	4.482	0.989	0.989
1004.64	32	2	1451	17910	3.648	4.558	0.989	0.989
1004.64	32	3	1462	16155	3.557	4.403	0.988	0.988
1004.64	33	1	1465	17784	3.714	4.722	0.989	0.989
1004.64	33	2	1469	17564	3.725	4.667	0.986	0.986
1004.64	33	3	1472	17762	3.667	4.364	0.987	0.987
1004.64	33	4	1473	17212	3.735	4.539	0.988	0.988
1004.64	34	1	1484	10881	3.886	4.667	0.986	0.986
1004.64	131	1	1464	16540	3.582	4.465	0.989	0.989
1004.64	131	2	1458	17046	3.591	4.517	0.987	0.987
1004.64	131	3	1458	16285	3.650	4.618	0.985	0.985

PT NO	SC	EXIT VAPOR QUALITY	SUPPLY TOTAL PRESSURE PSIA	INLET TOTAL PRESSURE PSIA	EXIT TOTAL PRESSURE PSIA	DOWN STREAM TOTAL PRESSURE PSIA	SUPPLY STATIC PRESSURE PSIA
130	1	0.911	19.59	19.61	5.34	3.71	19.47
130	2	0.917	19.68	19.62	5.36	3.76	19.62
130	3	0.910	20.44	20.37	5.62	3.95	20.31
49	1	0.783	21.89	21.83	6.37	3.41	21.87
49	2	0.804	21.92	21.18	6.47	3.28	21.96
49	3	0.802	22.43	22.48	6.49	3.30	22.42
49	4	0.800	22.41	22.46	6.53	3.25	22.34
57	1	0.885	20.88	20.78	6.18	3.36	20.92
57	2	0.888	20.51	20.16	6.18	3.09	20.52
57	3	0.889	20.09	19.93	5.97	2.89	20.05
57	4	0.896	19.29	19.26	5.84	2.74	19.08
58	1	0.908	18.31	17.93	5.42	2.31	18.07
58	2	0.873	18.85	18.79	5.62	2.55	18.80
58	3	0.869	20.44	20.23	5.96	2.76	20.40
58	4	0.864	19.88	19.67	5.95	2.52	19.82
59	1	0.817	20.69	20.66	6.18	2.62	20.69
59	2	0.814	20.21	19.94	6.33	2.60	20.16
59	3	0.805	20.28	20.73	6.07	2.55	19.97
59	4	0.810	19.93	19.72	6.09	2.46	19.82
47	1	0.911	21.69	21.53	5.69	3.18	21.59
47	2	0.906	22.11	21.83	5.87	3.24	22.10
47	3	0.920	21.93	21.56	5.71	3.15	21.92
47	4	0.923	21.55	21.70	5.74	3.04	21.38
48	1	0.881	21.85	21.68	5.71	3.16	21.81
48	2	0.869	20.31	21.02	5.74	3.30	20.67
48	3	0.872	21.28	21.10	5.64	3.32	21.27
48	4	0.885	21.11	21.15	5.67	3.39	21.05
48	5	0.883	21.55	21.46	5.84	3.61	21.47
31	1	0.934	22.29	22.30	6.30	4.24	22.25
32	1	0.933	20.04	19.99	5.43	3.76	20.01
32	2	0.931	19.31	18.98	5.29	3.64	19.22
32	3	0.937	20.30	20.29	5.71	3.94	20.19
33	1	0.920	20.56	20.29	5.54	3.55	20.55
33	2	0.918	21.33	21.49	5.73	3.80	21.23
33	3	0.920	21.58	21.32	5.88	4.17	21.66
33	4	0.929	21.73	21.54	5.82	4.11	21.75
34	1	0.956	21.51	21.59	5.54	3.76	21.38
131	1	0.925	20.93	20.86	5.84	3.93	20.88
131	2	0.926	20.38	20.34	5.67	3.76	20.36
131	3	0.934	20.47	20.33	5.61	3.66	20.46

PT NO	SC	TIP INLET STATIC PRESSURE PSIA	HUB INLET STATIC PRESSURE PSIA	1ST NOZ TIP EXIT STATIC PRESSURE PSIA	1ST NOZ HUB EXIT STATIC PRESSURE PSIA	1ST ROTOR TIP EXIT STATIC PRESSURE PSIA	1ST ROTOR HUB EXIT STATIC PRESSURE PSIA
130	1	18.73	18.82	14.93	13.44	10.68	12.94
130	2	18.77	18.81	14.98	13.51	10.72	13.00
130	3	19.64	19.71	15.90	14.54	11.39	13.57
49	1	21.07	21.10	17.14	15.78	12.27	14.30
49	2	22.11	21.13	17.76	16.92	12.51	14.62
49	3	21.55	21.62	17.58	16.04	12.39	14.64
49	4	21.50	21.54	17.48	16.02	12.39	14.54
57	1	20.09	20.09	16.41	14.62	11.47	13.69
57	2	19.27	19.36	15.97	14.03	11.03	13.30
57	3	19.13	19.14	15.48	13.87	10.87	13.00
57	4	18.42	18.45	14.81	13.38	10.48	12.61
58	1	17.15	17.19	13.86	12.55	9.69	11.66
58	2	18.03	18.08	14.68	13.42	10.34	12.41
58	3	19.62	19.53	15.90	14.46	11.21	13.38
58	4	18.95	18.90	15.38	14.24	10.93	13.71
59	1	20.01	20.03	16.06	14.91	11.49	13.53
59	2	19.07	19.15	16.68	14.18	10.50	13.46
59	3	19.66	19.79	15.78	14.48	11.25	13.22
59	4	19.11	19.00	15.48	14.50	11.27	13.40
47	1	20.52	20.65	16.74	14.97	11.54	14.07
47	2	21.31	21.27	17.30	15.56	12.00	14.32
47	3	20.95	20.72	16.84	15.54	12.10	14.38
47	4	20.88	20.87	16.51	14.85	11.64	13.89
48	1	20.99	20.97	16.72	15.27	11.78	14.14
48	2	21.58	21.77	17.53	17.10	11.96	14.50
48	3	20.33	20.30	16.30	15.11	11.72	13.99
48	4	20.39	20.39	16.13	14.81	11.49	13.73
48	5	20.90	20.85	16.81	15.39	11.84	14.22
31	1	21.41	21.26	17.10	15.60	12.21	14.54
32	1	19.18	19.19	15.21	13.49	10.83	12.96
32	2	18.52	18.35	14.50	13.14	10.50	12.67
32	3	19.55	19.52	15.41	13.79	11.03	13.28
33	1	19.33	19.37	15.41	13.49	10.91	13.26
33	2	20.49	20.56	16.33	14.38	11.41	13.59
33	3	20.31	20.37	16.15	14.32	11.39	13.75
33	4	20.70	20.69	16.50	14.76	11.70	13.87
34	1	20.60	20.66	16.09	14.46	11.49	13.73
131	1	19.88	19.96	15.92	14.14	11.27	13.53
131	2	19.77	19.79	15.51	13.87	11.07	13.28
131	3	19.49	19.47	15.17	[illegible]	10.91	13.08

PT NO	SC	2ND NOZ HUB EXIT STATIC PRESSURE PSIA	2ND ROTOR HUB EXIT STATIC PRESSURE PSIA	DOWN STREAM STATIC PRESSURE PSIA	DOWN STREAM TAYLOR STATIC PRESSURE PSIA	INLET CALORI-METER PRESSURE PSIA	INLET CALORI-METER TEMP DEG F
130	1	6.60	4.16	2.50	3.37	2.80	1174
130	2	6.56	4.24	2.59	3.49	2.86	1175
130	3	7.09	4.43	2.78	3.50	2.99	1178
49	1	7.45	4.87	2.64	2.04	2.84	1134
49	2	7.53	4.81	2.54	3.00	2.70	1132
49	3	7.60	4.96	2.50	3.01	2.76	1129
49	4	7.60	4.92	2.40	3.21	2.74	1128
57	1	7.03	4.61	2.65	3.29	2.90	1161
57	2	6.78	4.39	2.31	2.80	2.60	1149
57	3	6.58	4.24	2.05	2.56	2.30	1158
57	4	6.28	4.08	1.92	2.62	2.21	1160
58	1	5.89	3.74	1.39	2.48	1.87	1182
58	2	6.36	4.10	1.67	2.43	2.01	1148
58	3	6.84	4.37	1.87	2.68	2.17	1154
58	4	7.01	4.24	1.76	2.66	2.15	1153
59	1	7.03	4.43	1.74	2.41	2.15	1149
59	2	6.95	4.47	1.80	2.52	2.32	1148
59	3	6.76	4.37	1.61	1.52	2.05	1148
59	4	6.89	4.33	1.60	2.48	2.05	1147
47	1	7.29	4.77	2.33	3.33	2.64	1187
47	2	7.55	4.92	2.45	3.50	2.76	1186
47	3	7.51	4.81	2.31	3.24	2.54	1178
47	4	7.19	4.63	2.15	3.02	2.52	1173
48	1	7.29	4.67	2.33	3.27	2.58	1169
48	2	7.39	4.77	2.65	3.45	2.90	1174
48	3	7.25	4.61	2.59	3.73	2.86	1180
48	4	7.13	4.57	2.73	3.66	3.03	1191
48	5	7.53	4.87	2.97	3.79	3.19	1191
31	1	7.55	5.08	3.61	4.33	3.94	1190
32	1	6.54	4.47	3.36	4.07	3.51	1191
32	2	6.24	4.24	3.22	3.90	3.45	1190
32	3	6.70	4.61	3.55	4.05	3.74	1195
33	1	6.52	4.35	3.02	3.99	3.27	1186
33	2	6.82	4.57	3.17	4.39	3.45	1181
33	3	6.99	4.94	3.78	4.77	3.92	1198
33	4	7.11	4.79	3.59	4.43	3.86	1200
34	1	6.93	4.61	3.27	4.29	3.53	1186
131	1	6.91	4.69	3.36	3.98	3.59	1196
131	2	6.66	4.51	3.27	3.85	3.55	1185
131	3	6.50	4.43	3.13	3.73	3.37	1171

PT NO	SC	EXIT TEMP DEG F	1ST STAGE HUB REACTION	1ST STAGE TIP REACTION	2ND STAGE HUB REACTION	MAIN TORQUE READING IN-LB	SECONDARY TORQUE READING IN-LB
130	1	1113	0.087	0.540	0.355	506.3	29.7
130	2	1111	0.090	0.539	0.340	459.8	28.4
130	3	1127	0.163	0.559	0.369	483.0	28.1
49	1	1146	0.225	0.566	0.343	502.0	50.9
49	2	1149	0.354	0.614	0.349	483.6	60.3
49	3	1148	0.208	0.578	0.342	481.7	49.4
49	4	1148	0.218	0.570	0.347	486.0	51.1
57	1	1130	0.150	0.586	0.334	497.8	11.8
57	2	1120	0.119	0.584	0.330	486.2	2.1
57	3	1114	0.144	0.563	0.333	474.7	2.8
57	4	1110	0.135	0.555	0.325	490.1	26.9
58	1	1101	0.157	0.549	0.334	363.1	105.0
58	2	1112	0.181	0.571	0.341	492.5	98.7
58	3	1128	0.179	0.570	0.343	499.4	61.7
58	4	1118	0.100	0.558	0.370	498.1	58.4
59	1	1128	0.223	0.558	0.356	469.6	41.8
59	2	1124	0.126	0.695	0.340	496.3	47.5
59	3	1122	0.207	0.563	0.340	480.0	47.6
59	4	1132	0.194	0.546	0.352	486.4	56.8
47	1	1137	0.140	0.576	0.344	457.9	0.
47	2	1139	0.186	0.586	0.353	458.2	0.
47	3	1135	0.179	0.544	0.356	466.8	0.
47	4	1130	0.148	0.555	0.353	356.0	18.0
48	1	1135	0.171	0.554	0.353	447.2	0.
48	2	1136	0.482	0.714	0.376	412.1	5.5
48	3	1138	0.179	0.541	0.358	493.2	0.
48	4	1144	0.171	0.546	0.356	439.7	0.7
48	5	1153	0.184	0.574	0.361	441.8	1.1
31	1	1159	0.160	0.547	0.326	603.1	14.6
32	1	1144	0.089	0.539	0.312	531.4	21.9
32	2	1136	0.084	0.517	0.307	531.6	22.3
32	3	1159	0.086	0.535	0.308	537.0	20.5
33	1	1138	0.039	0.531	0.311	557.3	47.3
33	2	1157	0.121	0.561	0.320	563.4	46.3
33	3	1170	0.087	0.534	0.294	562.8	46.6
33	4	1164	0.134	0.542	0.324	563.6	58.4
34	1	1157	0.111	0.525	0.329	567.5	3.8
131	1	1151	0.098	0.545	0.317	576.5	22.2
131	2	1135	0.098	0.540	0.316	574.4	21.7
131	3	1138	0.083	0.510	0.305	538.4	24.9

PT NO	SC	TARE TORQUE READING IN-LB	TOTAL TORQUE READING IN-LB	EMFM FLOW PPS	SPRAY FLOW PPS	TURBINE IDEAL DROP BTU/LB	TURBINE WORK BTU/LB
130	1	106.8	583.4	1.589	0.010	103.8	81.0
130	2	107.0	538.4	1.572	0.019	103.9	75.7
130	3	109.8	564.8	1.576	0.009	103.4	80.7
49	1	104.3	555.4	1.943	0.282	84.7	62.0
49	2	100.3	523.6	2.026	0.270	85.0	54.4
49	3	104.6	536.9	2.031	0.264	86.5	57.4
49	4	92.6	527.5	1.846	0.244	85.9	56.9
57	1	112.1	598.0	1.864	0.052	95.0	73.3
57	2	105.0	589.1	1.796	0.047	93.7	71.4
57	3	107.8	579.8	1.769	0.050	94.7	72.8
57	4	102.2	565.4	1.758	0.049	93.3	68.7
58	1	105.1	363.3	1.846	0.097	92.7	42.9
58	2	99.9	493.7	1.770	0.110	90.8	58.6
58	3	95.6	533.3	1.755	0.108	92.8	61.9
58	4	109.2	549.0	1.794	0.105	91.2	68.6
59	1	90.7	518.5	1.937	0.244	85.1	52.5
59	2	96.8	545.7	1.943	0.238	82.2	57.7
59	3	104.4	536.8	1.968	0.260	84.4	59.2
59	4	94.4	524.0	1.965	0.262	82.9	53.8
47	1	98.7	556.6	2.079	0.065	104.1	55.8
47	2	102.3	560.5	2.117	0.073	102.9	56.6
47	3	93.9	560.7	2.114	0.052	105.4	53.3
47	4	101.9	439.8	2.040	0.059	103.1	46.0
48	1	94.4	541.6	2.114	0.132	100.5	51.7
48	2	105.2	511.8	2.158	0.160	93.7	51.7
48	3	102.1	595.2	2.169	0.140	99.4	58.6
48	4	99.0	538.0	2.161	0.131	99.0	52.0
48	5	91.2	531.8	2.121	0.137	98.0	49.4
31	1	71.1	659.5	1.846	0.001	101.7	56.8
32	1	91.0	600.5	1.917	0.004	104.3	61.6
32	2	93.7	603.1	1.921	0.004	103.3	63.1
32	3	82.2	598.7	1.895	0.006	101.7	57.2
33	1	92.8	602.8	1.663	0.006	105.0	72.3
33	2	91.2	608.3	1.672	0.005	105.2	71.6
33	3	92.6	608.9	1.703	0.005	104.2	71.2
33	4	88.6	593.8	1.799	0.006	105.7	63.7
34	1	52.3	616.0	1.854	0.005	108.3	40.5
131	1	84.4	638.8	1.750	0.001	102.5	67.7
131	2	87.3	640.1	1.876	0.003	102.3	65.2
131	3	83.0	596.5	1.910	0.003	103.3	57.0

PT NO	SC	POWER OUTPUT HP	POWER OUTPUT KW	CORRECTED SPEED RPM	CORRECTED TURBINE WORK BTU/LB	CORRECTED POWER KW	CORRECTED POWER HP
130	1	182	135	19942	83.2	265	355
130	2	168	125	19974	77.8	244	327
130	3	180	134	20334	82.7	250	336
49	1	170	127	20034	66.5	236	317
49	2	156	116	19416	58.1	212	285
49	3	165	123	20012	61.3	223	299
49	4	148	110	18349	60.7	201	269
57	1	193	144	20716	75.7	262	351
57	2	181	135	19764	73.9	255	341
57	3	182	135	20172	75.5	263	353
57	4	170	127	19401	71.3	253	339
58	1	112	83	19930	45.1	182	244
58	2	146	109	19215	61.6	226	304
58	3	153	114	18574	64.7	219	294
58	4	174	129	20460	71.8	255	342
59	1	143	107	18089	56.1	209	281
59	2	158	118	18951	61.7	236	317
59	3	164	122	20041	63.5	248	333
59	4	149	111	18629	57.7	221	297
47	1	164	122	18849	57.4	214	288
47	2	169	126	19339	58.2	219	294
47	3	159	119	18165	54.7	205	275
47	4	132	98	19285	47.3	173	233
48	1	154	115	18361	53.8	204	274
48	2	157	117	19890	54.1	212	284
48	3	179	134	19438	61.1	244	327
48	4	158	118	18990	54.1	212	285
48	5	148	110	17917	51.4	196	263
31	1	148	110	14313	57.9	186	250
32	1	167	124	17757	63.2	234	314
32	2	171	127	18143	64.7	243	327
32	3	153	114	16336	58.5	206	277
33	1	170	126	17973	73.8	226	302
33	2	169	126	17745	73.1	220	296
33	3	171	128	17935	72.6	220	296
33	4	162	120	17373	64.9	207	277
34	1	106	79	10964	41.2	128	172
131	1	167	125	16717	69.2	223	299
131	2	173	129	17254	66.8	238	319
131	3	154	114	16488	58.4	212	284

PT NO	SC	CORRECTED FLOW PPS	1ST STAGE WORK BTU/LB	2ND STAGE WORK BTU/LB	1ST STAGE PERCENT WORK	2ND STAGE PERCENT WORK	TOTAL TO TOTAL EFFICIENCY
130	1	3.018	21.5	59.5	26.53	73.47	0.780
130	2	2.978	19.9	55.7	26.34	73.66	0.729
130	3	2.874	21.6	59.2	26.72	73.28	0.781
49	1	3.374	17.4	44.6	28.03	71.97	0.732
49	2	3.465	14.2	40.2	26.17	73.83	0.641
49	3	3.458	16.0	41.4	27.88	72.12	0.664
49	4	3.139	15.9	41.0	28.03	71.97	0.662
57	1	3.285	20.4	53.0	27.78	72.22	0.772
57	2	3.268	19.3	52.1	27.00	73.00	0.763
57	3	3.307	19.9	52.9	27.39	72.61	0.769
57	4	3.365	18.5	50.2	26.89	73.11	0.736
58	1	3.832	11.4	31.6	26.46	73.54	0.463
58	2	3.486	15.7	42.9	26.74	73.26	0.646
58	3	3.216	16.5	45.3	26.73	73.27	0.667
58	4	3.367	15.8	52.9	22.95	77.05	0.752
59	1	3.543	14.4	38.2	27.33	72.67	0.617
59	2	3.631	14.8	42.9	25.68	74.32	0.702
59	3	3.716	16.7	42.4	28.28	71.72	0.701
59	4	3.641	13.4	40.4	24.93	75.07	0.649
47	1	3.549	15.2	40.6	27.20	72.80	0.536
47	2	3.570	15.9	40.7	28.11	71.89	0.550
47	3	3.560	13.8	39.5	25.91	74.09	0.506
47	4	3.486	12.8	33.1	27.93	72.07	0.446
48	1	3.608	14.1	37.6	27.21	72.79	0.514
48	2	3.720	14.5	37.3	27.97	72.03	0.552
48	3	3.788	15.4	43.2	26.27	73.73	0.590
48	4	3.731	14.3	37.7	27.49	72.51	0.525
48	5	3.627	13.4	35.9	27.22	72.78	0.504
31	1	3.060	15.7	41.1	27.67	72.33	0.559
32	1	3.518	17.3	44.3	28.15	71.85	0.591
32	2	3.572	16.7	46.3	26.53	73.47	0.611
32	3	3.349	15.9	41.3	27.86	72.14	0.563
33	1	2.901	19.4	52.9	26.86	73.14	0.689
33	2	2.862	20.8	50.8	29.06	70.94	0.681
33	3	2.883	20.8	50.4	29.19	70.81	0.683
33	4	3.023	18.2	45.5	28.61	71.39	0.603
34	1	2.965	11.3	29.2	27.89	72.11	0.374
131	1	3.059	19.1	48.6	28.23	71.77	0.661
131	2	3.383	18.5	46.7	28.39	71.61	0.638
131	3	3.439	16.0	41.0	28.05	71.95	0.552

PT NO	SC	TOTAL TO STATIC EFFICIENCY	TURBINE VELOCITY RATIO	EXPANSION EXPONENT
130	1	0.666	0.293	1.461
130	2	0.628	0.294	1.461
130	3	0.671	0.300	1.460
49	1	0.613	0.315	1.285
49	2	0.526	0.303	1.299
49	3	0.556	0.313	1.301
49	4	0.551	0.286	1.298
57	1	0.636	0.311	1.421
57	2	0.609	0.294	1.423
57	3	0.615	0.299	1.425
57	4	0.581	0.287	1.428
58	1	0.365	0.294	1.408
58	2	0.524	0.291	1.387
58	3	0.545	0.280	1.387
58	4	0.602	0.307	1.391
59	1	0.496	0.279	1.313
59	2	0.554	0.295	1.317
59	3	0.565	0.310	1.308
59	4	0.517	0.289	1.307
47	1	0.480	0.283	1.426
47	2	0.492	0.292	1.420
47	3	0.455	0.272	1.432
47	4	0.390	0.287	1.426
48	1	0.454	0.277	1.384
48	2	0.488	0.310	1.371
48	3	0.520	0.294	1.384
48	4	0.458	0.287	1.390
48	5	0.448	0.274	1.384
31	1	0.486	0.215	1.454
32	1	0.522	0.265	1.460
32	2	0.530	0.269	1.461
32	3	0.489	0.245	1.459
33	1	0.593	0.264	1.459
33	2	0.592	0.262	1.456
33	3	0.611	0.270	1.457
33	4	0.533	0.258	1.458
34	1	0.334	0.162	1.456
131	1	0.573	0.250	1.460
131	2	0.550	0.257	1.458
131	3	0.476	0.244	1.455

TABLE VI (Cont'd)

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

Test Dates:	Oct. 4 & 8, 1964
Nominal Inlet Temperature, °F:	1450
Nominal Inlet Quality, Percent:	85, 92, 95, 99
Total to Total Pressure Ratio:	2.099 to 3.756

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

DATE	PT NO	SC	TURBINE INLET TEMP DEG F	SPEED RPM	TOTAL TO TOTAL PRESSURE RATIO	TOTAL TO STATIC PRESSURE RATIO	SUPPLIED VAPOR QUALITY	INLET VAPOR QUALITY
1004.64	131	4	1462	15990	3.690	4.578	0.984	0.984
1008.64	7	1	1467	19239	2.257	2.350	0.994	0.961
1008.64	7	2	1472	19439	2.099	2.175	0.994	0.967
1008.64	7	3	1471	19330	2.179	2.239	0.993	0.951
1008.64	7	4	1468	18783	2.215	2.274	0.993	0.952
1008.64	8	1	1472	17798	2.132	2.188	0.992	0.925
1008.64	8	2	1475	15948	2.167	2.265	0.993	0.926
1008.64	8	3	1479	15305	2.180	2.351	0.996	0.944
1008.64	9	1	1470	18990	2.159	2.218	0.994	0.871
1008.64	9	2	1479	17498	2.126	2.229	0.995	0.856
1008.64	9	3	1468	19464	2.284	2.363	0.996	0.857
1008.64	9	4	1462	18628	2.220	2.278	0.993	0.850
1008.64	17	1	1485	18290	3.213	3.631	0.985	0.940
1008.64	17	2	1481	18690	3.298	3.621	0.985	0.937
1008.64	17	3	1483	16824	2.957	3.200	0.986	0.939
1008.64	17	4	1480	17873	2.912	3.096	0.986	0.950
1008.64	18	1	1483	18546	3.331	3.538	0.989	0.914
1008.64	18	2	1482	19348	3.385	3.706	0.988	0.914
1008.64	18	3	1482	19348	3.385	3.706	0.988	0.914
1008.64	18	4	1481	18805	3.354	3.611	0.987	0.914
1008.64	19	1	1487	16717	3.128	3.388	0.987	0.834
1008.64	19	2	1485	19687	3.347	3.635	0.988	0.856
1008.64	19	3	1485	20043	3.349	3.675	0.988	0.855
1008.64	27	1	1488	18447	3.635	4.044	0.985	0.947
1008.64	27	2	1489	18052	3.741	4.321	0.988	0.931
1008.64	27	3	1486	18349	3.756	4.333	0.987	0.941
1008.64	27	4	1482	18575	3.608	4.229	0.985	0.943
1008.64	28	1	1478	18118	3.614	4.104	0.986	0.905
1008.64	28	2	1479	17518	3.586	4.085	0.985	0.906
1008.64	28	3	1482	17271	3.478	4.178	0.986	0.899
1008.64	28	4	1481	19371	3.708	4.206	0.986	0.898
1008.64	29	1	1486	18148	3.606	4.117	0.982	0.834
1008.64	29	2	1487	18232	3.627	4.071	0.983	0.838
1008.64	29	3	1490	18269	3.653	4.238	0.983	0.848
1008.64	29	4	1490	18473	3.684	4.231	0.983	0.837
1008.64	37	1	1478	17687	3.585	4.271	0.987	0.947
1008.64	37	2	1476	19104	3.748	4.457	0.988	0.933
1008.64	37	3	1474	17786	3.682	4.428	0.988	0.937
1008.64	37	4	1474	17955	3.692	4.327	0.987	0.934
1008.64	38	1	1468	19485	3.694	4.367	0.988	0.924

PT SC NO	EXIT VAPOR QUALITY	SUPPLY TOTAL PRESSURE PSIA	INLET TOTAL PRESSURE PSIA	EXIT TOTAL PRESSURE PSIA	DOWN STREAM TOTAL PRESSURE PSIA	SUPPLY STATIC PRESSURE PSIA
131 4	0.914	20.74	20.74	5.62	3.56	20.71
7 1	0.932	20.97	21.01	9.29	8.71	20.79
7 2	0.944	21.34	21.51	10.17	9.56	21.01
7 3	0.923	21.70	21.75	9.96	9.41	21.53
7 4	0.929	21.28	21.24	9.61	9.01	21.03
8 1	0.910	22.72	22.36	10.66	10.11	22.18
8 2	0.912	21.37	21.24	9.86	9.09	21.29
8 3	0.933	21.30	21.24	9.77	9.21	21.20
9 1	0.862	21.24	21.20	9.84	9.20	21.12
9 2	0.851	21.51	21.39	10.12	9.32	21.40
9 3	0.841	21.04	20.95	9.21	8.59	20.92
9 4	0.838	21.01	20.94	9.46	8.86	20.83
17 1	0.903	22.89	22.69	7.12	5.67	22.82
17 2	0.902	22.83	22.52	6.92	5.64	22.73
17 3	0.908	22.50	22.38	7.61	6.28	22.44
17 4	0.909	21.53	22.06	7.39	6.24	21.48
18 1	0.879	22.79	22.56	6.84	5.53	22.49
18 2	0.873	22.85	22.74	6.75	5.52	22.80
18 3	0.873	22.85	22.74	6.75	5.52	22.80
18 4	0.883	22.90	22.77	6.83	5.71	22.79
19 1	0.810	23.36	23.19	7.47	5.99	23.30
19 2	0.818	23.06	23.07	6.89	5.61	22.80
19 3	0.821	23.02	22.96	6.88	5.53	22.91
27 1	0.911	23.18	22.88	6.38	4.43	23.17
27 2	0.898	23.41	23.42	6.26	4.06	23.31
27 3	0.908	23.31	23.06	6.21	4.20	23.22
27 4	0.904	22.91	22.76	6.35	4.33	22.79
28 1	0.865	22.23	22.26	6.15	4.18	22.12
28 2	0.869	22.37	22.38	6.24	4.47	22.21
28 3	0.863	22.22	22.29	6.39	4.14	22.01
28 4	0.854	22.62	22.68	6.10	4.01	22.41
29 1	0.814	23.28	23.08	6.46	4.26	23.16
29 2	0.816	23.34	23.08	6.44	4.39	23.28
29 3	0.824	23.63	23.47	6.47	4.30	23.48
29 4	0.809	23.59	23.65	6.40	4.16	23.43
37 1	0.908	22.13	22.27	6.17	3.78	21.13
37 2	0.885	22.30	22.20	5.95	3.49	22.21
37 3	0.896	21.81	21.82	5.92	3.40	21.63
37 4	0.894	21.99	21.78	5.96	3.58	21.82
38 1	0.884	21.59	21.50	5.84	3.49	21.52

PT NO	SC	TIP INLET STATIC PRESSURE PSIA	HUB INLET STATIC PRESSURE PSIA	1ST NOZ TIP EXIT STATIC PRESSURE PSIA	1ST NOZ HUB EXIT STATIC PRESSURE PSIA	1ST ROTOR TIP EXIT STATIC PRESSURE PSIA	1ST ROTOR HUB EXIT STATIC PRESSURE PSIA
131	4	19.86	19.84	15.69	14.38	11.33	13.49
7	1	20.38	20.36	17.85	16.55	13.46	15.33
7	2	21.16	21.16	18.35	17.20	14.24	15.98
7	3	21.42	21.34	18.44	17.45	14.30	16.08
7	4	20.65	20.65	18.06	16.84	13.85	15.68
8	1	21.03	21.08	18.55	17.20	14.36	16.17
8	2	20.83	20.68	18.14	17.06	14.09	15.76
8	3	20.51	20.49	17.59	16.63	13.59	15.37
9	1	20.83	20.77	18.20	17.36	14.18	15.96
9	2	20.75	20.63	18.22	17.18	14.07	15.76
9	3	20.36	20.26	17.78	17.47	14.20	15.78
9	4	20.45	20.31	17.71	16.82	13.69	15.43
17	1	21.91	21.81	18.67	16.78	13.06	15.35
17	2	21.75	21.49	18.35	16.86	13.24	15.41
17	3	21.48	21.50	20.11	16.59	12.84	15.37
17	4	22.52	22.93	19.30	18.85	13.38	15.82
18	1	21.98	21.81	18.52	17.30	13.40	15.66
18	2	21.89	21.83	18.61	17.10	13.20	15.48
18	3	21.89	21.83	18.61	17.10	13.20	15.48
18	4	22.08	22.05	18.55	17.18	13.36	15.64
19	1	22.77	22.63	19.40	17.75	13.89	16.06
19	2	22.39	22.34	18.81	17.43	13.63	15.82
19	3	22.26	22.11	18.81	17.34	13.57	15.86
27	1	22.51	22.02	18.26	16.78	13.04	15.25
27	2	22.62	22.38	18.63	16.80	12.94	15.44
27	3	22.25	22.09	18.20	16.57	12.79	15.21
27	4	22.03	21.94	18.12	16.61	12.92	15.05
28	1	21.64	21.60	17.75	16.43	12.63	14.83
28	2	21.42	21.38	17.70	16.00	12.29	14.64
28	3	21.75	21.55	17.98	16.33	12.59	14.76
28	4	21.68	21.67	17.79	16.15	12.45	14.68
29	1	22.14	22.06	18.33	16.88	13.20	15.33
29	2	22.44	22.36	18.59	17.08	13.26	15.39
29	3	22.77	22.53	18.69	17.28	13.44	15.50
29	4	22.58	22.58	18.78	17.38	13.46	15.66
37	1	21.71	21.50	17.39	15.90	12.15	14.62
37	2	21.15	21.06	16.90	15.15	11.90	14.18
37	3	21.43	21.14	16.93	15.21	11.98	14.16
37	4	21.11	20.77	16.79	15.19	12.02	14.14
38	1	20.96	20.75	16.53	15.[illegible]5	11.76	13.97

PT NO	SC	2ND NOZ HUB EXIT STATIC PRESSURE PSIA	2ND ROTOR HUB EXIT STATIC PRESSURE PSIA	DOWN STREAM STATIC PRESSURE PSIA	DOWN STREAM TAYLOR STATIC PRESSURE PSIA	INLET CALORI-METER PRESSURE PSIA	INLET CALORI-METER TEMP DEG F
131	4	6.84	4.53	3.01	3.63	3.29	1166
7	1	9.95	8.92	8.54	9.92	8.65	1312
7	2	10.87	9.81	9.51	10.60	9.50	1326
7	3	10.80	9.69	9.31	10.20	9.42	1322
7	4	10.36	9.36	8.94	10.65	9.02	1316
8	1	11.21	10.38	9.96	10.52	10.15	1331
8	2	10.60	9.44	8.96	9.89	9.14	1315
8	3	10.09	9.06	9.26	11.05	8.83	1323
9	1	10.68	9.57	9.16	10.10	9.20	1320
9	2	10.72	9.65	9.38	10.66	9.26	1325
9	3	10.03	8.90	8.52	9.92	8.53	1317
9	4	10.24	9.22	8.80	10.20	8.85	1312
17	1	8.41	6.30	5.48	6.49	5.58	1231
17	2	8.16	6.30	5.51	6.49	5.69	1231
17	3	8.27	7.03	5.93	7.18	6.36	1236
17	4	8.90	6.95	6.18	6.96	6.32	1242
18	1	8.21	6.44	5.47	6.63	5.58	1245
18	2	8.27	6.17	5.34	6.61	5.48	1240
18	3	8.27	6.17	5.34	6.61	5.48	1240
18	4	8.25	6.34	5.58	6.66	5.65	1240
19	1	8.71	6.89	5.86	6.79	6.05	1249
19	2	8.35	6.34	5.51	6.57	5.59	1240
19	3	8.39	6.26	5.45	6.37	5.58	1241
27	1	8.16	5.73	4.28	5.15	4.43	1205
27	2	8.14	5.42	4.01	5.11	4.26	1213
27	3	8.02	5.38	4.09	5.15	4.27	1210
27	4	7.80	5.42	4.21	5.27	4.45	1205
28	1	7.90	5.42	4.06	5.12	4.20	1202
28	2	7.96	5.48	4.36	5.15	4.55	1207
28	3	7.78	5.32	4.00	4.89	4.22	1202
28	4	7.76	5.38	3.91	4.95	4.10	1199
29	1	8.31	5.65	4.12	5.13	4.29	1192
29	2	8.41	5.73	4.28	5.11	4.45	1198
29	3	8.45	5.58	4.20	5.21	4.35	1197
29	4	8.51	5.58	4.05	5.04	4.26	1195
37	1	7.92	5.18	3.62	4.24	3.80	1198
37	2	7.55	5.00	3.36	4.08	3.62	1195
37	3	7.56	4.92	3.17	4.00	3.39	1189
37	4	7.55	5.08	3.41	4.21	3.61	1191
38	1	7.53	4.94	3.30	4.09	3.45	1189

PT NO	SC	EXIT TEMP DEG F	1ST STAGE HUB REACTION	1ST STAGE TIP REACTION	2ND STAGE HUB REACTION	MAIN TORQUE READING IN-LB	SECONDARY TORQUE READING IN-LB
131	4	1139	0.143	0.526	0.328	574.2	23.5
7	1	1302	0.240	0.628	0.182	179.0	20.1
7	2	1318	0.250	0.619	0.197	178.2	72.9
7	3	1314	0.269	0.601	0.198	183.8	34.7
7	4	1306	0.230	0.610	0.180	169.1	39.7
8	1	1323	0.177	0.548	0.148	154.9	50.2
8	2	1310	0.255	0.599	0.204	150.5	24.4
8	3	1323	0.236	0.565	0.178	139.2	33.9
9	1	1310	0.289	0.610	0.197	156.6	79.7
9	2	1322	0.272	0.601	0.189	158.9	94.3
9	3	1302	0.349	0.564	0.188	157.4	32.1
9	4	1312	0.276	0.593	0.186	143.3	30.5
17	1	1229	0.218	0.625	0.285	422.9	126.7
17	2	1229	0.224	0.589	0.253	398.7	117.4
17	3	1247	0.195	0.792	0.184	403.9	111.7
17	4	1243	0.563	0.763	0.297	452.1	119.7
18	1	1227	0.259	0.599	0.246	430.8	129.4
18	2	1223	0.249	0.615	0.285	439.9	118.7
18	3	1223	0.249	0.615	0.285	439.9	118.7
18	4	1226	0.240	0.598	0.263	380.9	117.1
19	1	1236	0.262	0.634	0.249	426.7	113.9
19	2	1226	0.252	0.603	0.272	438.6	113.8
19	3	1227	0.234	0.608	0.282	402.3	117.2
27	1	1200	0.223	0.574	0.320	452.7	71.4
27	2	1190	0.197	0.603	0.344	455.4	73.6
27	3	1186	0.195	0.576	0.338	455.0	76.6
27	4	1194	0.228	0.579	0.314	451.8	80.7
28	1	1190	0.246	0.591	0.337	443.6	83.6
28	2	1196	0.204	0.597	0.337	440.4	79.2
28	3	1192	0.242	0.616	0.330	431.1	78.0
28	4	1181	0.216	0.586	0.325	439.7	82.4
29	1	1199	0.225	0.568	0.342	415.2	102.0
29	2	1196	0.244	0.587	0.347	423.5	93.6
29	3	1196	0.251	0.573	0.360	424.2	87.9
29	4	1190	0.247	0.584	0.365	441.6	79.1
37	1	1169	0.197	0.585	0.364	458.9	50.3
37	2	1165	0.141	0.546	0.344	493.4	53.5
37	3	1163	0.160	0.566	0.360	480.3	51.1
37	4	1166	0.156	0.542	0.337	470.3	55.1
38	1	1027	0.166	0.548	0.358	472.0	63.9

PT NO	SC	TARE TORQUE READING IN-LB	TOTAL TORQUE READING IN-LB	EMFM FLOW PPS	SPRAY FLOW PPS	TURBINE IDEAL DROP BTU/LB	TURBINE WORK BTU/LB
131	4	81.3	632.0	1.547	0.003	104.1	73.2
7	1	103.6	262.5	1.704	0.051	65.9	33.2
7	2	105.1	210.4	1.696	0.042	60.8	27.0
7	3	104.2	253.4	1.718	0.066	62.8	32.0
7	4	100.2	229.6	1.715	0.064	64.0	28.2
8	1	92.9	197.7	1.754	0.109	59.7	22.5
8	2	81.1	207.2	1.763	0.109	60.7	21.0
8	3	77.4	182.7	1.763	0.086	62.3	17.8
9	1	101.7	178.6	2.106	0.253	56.9	18.1
9	2	90.7	155.3	2.011	0.272	54.9	15.1
9	3	105.2	230.6	2.000	0.273	59.7	25.2
9	4	99.1	211.9	2.002	0.282	57.4	22.1
17	1	96.6	392.8	1.774	0.071	90.6	45.4
17	2	99.5	380.8	1.802	0.076	92.2	44.3
17	3	86.0	378.2	1.822	0.076	84.5	39.2
17	4	93.5	425.9	1.821	0.059	84.1	46.9
18	1	98.4	399.8	1.835	0.127	90.6	45.3
18	2	104.4	425.6	1.839	0.128	91.7	50.2
18	3	104.4	425.6	1.839	0.128	91.7	50.2
18	4	100.4	364.2	1.843	0.128	91.1	41.7
19	1	85.4	398.2	2.013	0.296	79.1	37.1
19	2	106.9	431.6	1.942	0.251	85.4	49.1
19	3	109.5	394.6	1.944	0.255	85.3	45.6
27	1	97.7	479.0	2.174	0.074	100.1	45.6
27	2	94.8	476.6	2.193	0.112	100.4	44.0
27	3	97.0	475.4	2.224	0.092	101.7	44.0
27	4	98.7	469.7	2.045	0.078	99.0	47.9
28	1	95.3	455.4	1.851	0.141	95.0	50.0
28	2	90.8	452.0	1.851	0.138	94.7	48.0
28	3	89.0	442.1	1.843	0.152	91.9	46.5
28	4	104.6	461.8	1.846	0.155	96.2	54.3
29	1	95.5	408.7	2.328	0.336	88.0	35.7
29	2	96.1	426.0	2.309	0.328	88.8	37.7
29	3	96.4	432.7	2.265	0.303	90.3	39.1
29	4	97.9	460.5	2.257	0.327	89.7	42.3
37	1	92.1	500.7	2.039	0.071	98.8	48.7
37	2	102.6	542.5	2.059	0.100	100.4	56.5
37	3	92.8	522.1	2.083	0.093	99.5	50.0
37	4	94.1	509.3	2.066	0.096	99.4	49.6
38	1	105.4	[illegible]	2.248	0.132	98.3	49.9

PT NO	SC	POWER OUTPUT HP	POWER OUTPUT KW	CORRECTED SPEED RPM	CORRECTED TURBINE WORK BTU/LB	CORRECTED POWER KW	CORRECTED POWER HP
131	4	160	119	16180	75.0	216	290
7	1	80	59	19525	34.2	107	143
7	2	64	48	19690	27.7	84	113
7	3	77	57	19636	33.0	102	137
7	4	68	51	19[illegible]96	29.1	91	122
8	1	55	41	18153	23.4	74	99
8	2	52	39	16253	21.8	68	92
8	3	44	33	15543	18.3	56	75
9	1	53	40	19563	19.2	75	100
9	2	43	32	18047	16.1	58	77
9	3	71	53	20112	26.9	101	136
9	4	62	46	19289	23.7	92	123
17	1	113	85	18565	46.8	141	189
17	2	112	84	18995	45.7	143	192
17	3	100	75	17086	40.4	126	169
17	4	120	90	18129	48.2	152	204
18	1	117	87	18916	47.1	149	200
18	2	130	97	19738	52.2	167	223
18	3	130	97	19738	52.2	167	223
18	4	108	81	19189	43.4	139	187
19	1	105	78	17290	39.7	139	186
19	2	134	100	20284	52.1	176	236
19	3	125	93	20657	48.4	164	220
27	1	140	104	18694	46.8	170	228
27	2	136	101	18342	45.4	167	224
27	3	138	103	18619	45.3	170	228
27	4	138	103	18856	49.3	173	233
28	1	130	97	18525	52.2	171	229
28	2	125	93	17906	50.1	164	220
28	3	121	90	17666	48.6	156	210
28	4	141	105	19819	56.9	183	246
29	1	117	87	18773	38.2	155	208
29	2	123	91	18841	40.3	161	216
29	3	125	93	18835	41.6	161	215
29	4	134	100	19088	45.1	175	234
37	1	140	104	17955	50.2	179	241
37	2	164	122	19448	58.5	214	287
37	3	147	109	18097	51.7	192	258
37	4	145	108	18281	51.4	190	255
38	1	158	118	19893	52.0	216	289

PT NO	SC	CORRECTED FLOW PPS	1ST STAGE WORK BTU/LB	2ND STAGE WORK BTU/LB	1ST STAGE PERCENT WORK	2ND STAGE PERCENT WORK	TOTAL TO TOTAL EFFICIENCY
131	4	2.736	20.2	53.0	27.62	72.38	0.704
7	1	2.971	11.6	21.6	34.99	65.01	0.504
7	2	2.880	10.0	17.0	37.01	62.99	0.444
7	3	2.949	11.6	20.3	36.44	63.56	0.509
7	4	2.984	9.9	18.3	35.16	64.84	0.441
8	1	3.018	8.5	14.0	37.58	62.42	0.377
8	2	2.982	7.3	13.7	34.85	65.15	0.346
8	3	2.919	6.3	11.5	35.45	64.55	0.286
9	1	3.711	6.2	11.9	34.20	65.80	0.318
9	2	3.421	5.4	9.8	35.50	64.50	0.276
9	3	3.578	7.7	17.4	30.72	69.28	0.421
9	4	3.683	7.8	14.4	35.08	64.92	0.385
17	1	2.856	13.2	32.2	29.10	70.90	0.501
17	2	2.968	12.3	32.0	27.81	72.19	0.481
17	3	2.965	12.0	27.2	30.68	69.32	0.463
17	4	2.995	15.1	31.8	32.13	67.87	0.557
18	1	3.009	12.6	32.7	27.82	72.18	0.500
18	2	3.030	14.1	36.1	28.01	71.99	0.547
18	3	3.030	14.1	36.1	28.01	71.99	0.547
18	4	3.055	11.7	29.9	28.18	71.82	0.457
19	1	3.323	10.9	26.2	29.45	70.55	0.469
19	2	3.209	13.9	35.2	28.30	71.70	0.575
19	3	3.217	12.4	33.2	27.12	72.88	0.535
27	1	3.456	12.8	32.8	28.01	71.99	0.456
27	2	3.493	11.8	32.2	26.84	73.16	0.438
27	3	3.569	11.9	32.1	27.10	72.90	0.432
27	4	3.339	13.3	34.6	27.78	72.22	0.483
28	1	3.109	14.0	35.9	28.08	71.92	0.526
28	2	3.103	13.8	34.2	28.67	71.33	0.507
28	3	3.055	13.0	33.5	27.99	72.01	0.505
28	4	3.064	15.7	38.6	28.98	71.02	0.565
29	1	3.859	9.7	26.0	27.26	72.74	0.406
29	2	3.806	10.6	27.2	28.02	71.98	0.425
29	3	3.669	10.7	28.4	27.37	72.63	0.433
29	4	3.677	11.3	30.9	26.84	73.16	0.471
37	1	3.396	13.7	35.1	28.04	71.96	0.493
37	2	3.473	16.1	40.3	28.58	71.42	0.562
37	3	3.530	14.2	35.8	28.45	71.55	0.502
37	4	3.516	14.0	35.6	28.17	71.83	0.499
38	1	3.939	14.3	35.7	28.55	71.45	0.508

PT NO	SC	TOTAL TO STATIC EFFICIENCY	TURBINE VELOCITY RATIO	EXPANSION EXPONENT
131	4	0.614	0.240	1.454
7	1	0.482	0.380	1.428
7	2	0.425	0.400	1.435
7	3	0.493	0.394	1.416
7	4	0.427	0.379	1.418
8	1	0.365	0.372	1.388
8	2	0.328	0.327	1.389
8	3	0.262	0.305	1.408
9	1	0.307	0.406	1.326
9	2	0.260	0.376	1.309
9	3	0.406	0.405	1.310
9	4	0.374	0.397	1.304
17	1	0.458	0.301	1.404
17	2	0.449	0.309	1.401
17	3	0.435	0.291	1.403
17	4	0.530	0.312	1.415
18	1	0.478	0.313	1.375
18	2	0.513	0.321	1.374
18	3	0.513	0.321	1.374
18	4	0.433	0.315	1.374
19	1	0.441	0.299	1.284
19	2	0.541	0.339	1.309
19	3	0.500	0.344	1.307
27	1	0.424	0.292	1.412
27	2	0.399	0.282	1.394
27	3	0.394	0.285	1.405
27	4	0.435	0.291	1.407
28	1	0.483	0.292	1.364
28	2	0.464	0.283	1.366
28	3	0.447	0.278	1.358
28	4	0.520	0.311	1.356
29	1	0.371	0.303	1.284
29	2	0.393	0.305	1.289
29	3	0.393	0.300	1.299
29	4	0.430	0.306	1.287
37	1	0.439	0.276	1.412
37	2	0.504	0.296	1.396
37	3	0.446	0.276	1.401
37	4	0.451	0.281	1.397
38	1	0.456	0.305	1.386

TABLE VI (Cont'd)

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

Test Date:	Oct. 8, 1964
Nominal Inlet Temperature, °F:	1450, 1550
Nominal Inlet Quality, Percent:	85, 92, 95
Total to Total Pressure Ratio:	2.442 to 3.967

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

DATE	PT NO	SC	TURBINE INLET TEMP DEG F	SPEED RPM	TOTAL TO TOTAL PRESSURE RATIO	TOTAL TO STATIC PRESSURE RATIO	SUPPLIED VAPOR QUALITY	INLET VAPOR QUALITY
1008.64	38	2	1468	19508	3.727	4.447	0.985	0.920
1008.64	38	3	1470	16136	3.488	4.147	0.984	0.912
1008.64	38	4	1469	18344	3.794	4.606	0.988	0.918
1008.64	39	1	1476	18587	3.754	4.441	0.987	0.840
1008.64	39	2	1476	19645	3.823	4.564	0.988	0.842
1008.64	39	3	1476	19245	3.761	4.425	0.986	0.853
1008.64	39	4	1476	18870	3.592	4.203	0.985	0.839
1008.64	67	1	1543	18090	2.969	3.121	0.988	0.938
1008.64	67	2	1542	18042	3.119	3.292	0.987	0.953
1008.64	67	3	1544	19217	3.246	3.507	0.986	0.937
1008.64	68	1	1546	18423	2.918	2.674	0.990	0.910
1008.64	68	2	1545	19826	2.442	2.543	0.991	0.922
1008.64	68	3	1545	18153	3.115	3.340	0.985	0.854
1008.64	69	1	1547	17951	2.946	3.123	0.986	0.836
1008.64	69	2	1544	18512	3.041	3.246	0.985	0.845
1008.64	76	1	1539	19149	3.735	4.281	0.984	0.951
1008.64	76	2	1541	19056	3.693	4.219	0.985	0.928
1008.64	76	3	1542	18050	3.748	4.233	0.985	0.950
1008.64	76	4	1542	19039	3.800	4.305	0.985	0.936
1008.64	77	1	1547	19212	3.744	4.216	0.985	0.897
1008.64	77	2	1545	19701	3.783	4.224	0.987	0.911
1008.64	78	1	1542	17850	3.627	4.199	0.983	0.845
1008.64	78	2	1546	18781	3.371	3.830	0.984	0.843
1008.64	85	1	1533	18959	3.916	4.470	0.984	0.937
1008.64	85	2	1534	18373	3.862	4.585	0.984	0.941
1008.64	85	3	1535	19062	3.907	4.650	0.984	0.950
1008.64	85	4	1531	19056	3.967	4.730	0.984	0.957
1008.64	86	1	1532	19366	3.865	4.649	0.983	0.899
1008.64	86	2	1533	18672	3.835	4.516	0.984	0.909
1008.64	86	3	1534	19115	3.916	4.564	0.984	0.907
1008.64	86	4	1533	19037	3.934	4.596	0.984	0.906
1008.64	87	1	1536	19044	3.728	4.388	0.983	0.847
1008.64	87	2	1537	17633	3.515	4.071	0.983	0.842
1008.64	87	3	1535	18792	3.872	4.583	0.984	0.857
1008.64	87	4	1536	18804	3.826	4.614	0.983	0.851
1008.64	94	1	1525	19320	3.939	4.674	0.983	0.944
1008.64	94	2	1527	18914	3.861	4.573	0.983	0.941
1008.64	94	3	1529	19088	3.940	4.748	0.983	0.953
1008.64	94	4	1530	19291	3.936	4.651	0.981	0.943
1008.64	95	1	1533	18390	3.919	4.578	0.981	0.920

PT NO	SC	EXIT VAPOR QUALITY	SUPPLY TOTAL PRESSURE PSIA	INLET TOTAL PRESSURE PSIA	EXIT TOTAL PRESSURE PSIA	DOWN STREAM TOTAL PRESSURE PSIA	SUPPLY STATIC PRESSURE PSIA
38	2	0.876	21.64	21.63	5.80	3.64	21.47
38	3	0.883	21.32	21.16	6.11	3.78	21.24
38	4	0.886	21.60	21.53	5.69	3.18	21.46
39	1	0.817	22.14	22.06	5.90	3.29	22.01
39	2	0.819	22.12	21.92	5.79	2.92	22.10
39	3	0.832	22.23	22.18	5.91	3.26	22.14
39	4	0.816	21.94	22.04	6.11	3.66	21.72
67	1	0.902	30.43	30.43	10.25	8.90	30.37
67	2	0.913	30.42	30.32	9.75	8.19	30.35
67	3	0.892	30.33	30.36	9.34	7.72	30.13
68	1	0.876	30.71	30.51	10.53	9.88	30.67
68	2	0.895	30.81	30.86	12.61	11.62	30.66
68	3	0.827	30.67	30.56	9.84	8.00	30.56
69	1	0.816	31.07	30.73	10.55	9.02	31.00
69	2	0.825	30.38	30.45	9.99	8.39	30.27
76	1	0.901	30.19	30.16	8.08	5.52	30.08
76	2	0.889	29.92	29.95	8.10	5.56	29.77
76	3	0.903	30.27	30.13	8.08	5.54	30.31
76	4	0.890	30.36	29.97	7.99	5.41	30.33
77	1	0.852	30.73	30.67	8.21	5.39	30.59
77	2	0.864	30.71	30.57	8.12	5.45	30.60
78	1	0.817	30.27	30.33	8.35	5.46	30.08
78	2	0.810	28.82	30.17	8.55	5.78	27.81
85	1	0.898	29.06	28.93	7.42	4.49	28.79
85	2	0.895	29.27	29.08	7.58	4.24	29.15
85	3	0.899	29.22	29.12	7.48	3.84	29.14
85	4	0.906	28.89	28.81	7.28	3.51	28.66
86	1	0.858	29.03	29.09	7.51	4.16	28.81
86	2	0.871	29.09	28.94	7.58	4.35	29.05
86	3	0.869	29.31	29.20	7.49	4.35	29.18
86	4	0.861	29.06	29.07	7.39	4.06	28.86
87	1	0.812	29.31	29.25	7.86	4.53	29.13
87	2	0.813	28.87	28.62	8.21	4.41	28.84
87	3	0.826	29.16	29.16	7.53	3.68	29.09
87	4	0.820	29.27	29.23	7.65	3.61	29.06
94	1	0.897	28.27	28.14	7.18	3.64	28.14
94	2	0.893	27.66	27.53	7.16	3.59	27.57
94	3	0.907	28.43	28.35	7.22	3.18	28.24
94	4	0.893	28.58	28.37	7.26	3.17	28.50
95	1	0.877	29.13	28.91	7.43	3.54	28.92

PT NO	SC	TIP INLET STATIC PRESSURE PSIA	HUB INLET STATIC PRESSURE PSIA	1ST NOZ TIP EXIT STATIC PRESSURE PSIA	1ST NOZ HUB EXIT STATIC PRESSURE PSIA	1ST ROTOR TIP EXIT STATIC PRESSURE PSIA	1ST RCTOR HUB EXIT STATIC PRESSURE PSIA
38	2	20.67	20.56	16.43	14.99	11.68	13.99
38	3	20.67	20.44	16.69	15.13	11.62	13.99
38	4	20.64	20.50	16.51	15.01	11.64	13.93
39	1	21.57	21.34	17.37	15.66	12.31	14.09
39	2	21.49	21.32	17.08	15.78	12.31	14.38
39	3	21.39	21.36	17.27	15.60	12.21	14.26
39	4	21.54	21.48	17.39	15.76	12.31	14.38
67	1	29.29	29.27	23.95	22.00	17.69	20.49
67	2	29.38	29.22	24.11	22.02	17.69	20.37
67	3	29.18	29.10	23.99	21.91	17.30	20.19
68	1	29.57	29.32	24.99	22.28	17.93	20.57
68	2	29.63	29.56	24.79	22.79	18.70	21.30
68	3	29.70	29.38	24.26	22.30	17.97	20.47
69	1	29.84	29.66	24.72	22.69	18.40	20.88
69	2	29.47	29.44	24.44	22.14	17.91	20.33
76	1	29.05	29.02	23.68	21.43	17.02	20.00
76	2	28.89	28.83	23.68	21.47	17.06	19.96
76	3	29.35	28.97	23.89	21.63	17.14	20.00
76	4	29.20	29.06	23.66	21.73	17.12	20.13
77	1	29.71	29.53	24.32	22.26	17.63	20.59
77	2	29.66	29.52	24.08	22.18	17.51	20.49
78	1	29.19	29.11	23.67	21.85	17.63	20.13
78	2	29.64	29.40	24.45	23.60	17.79	20.21
85	1	27.88	27.82	22.82	20.57	16.35	19.15
85	2	28.21	28.07	23.00	20.72	16.43	19.13
85	3	28.04	27.95	22.88	20.63	16.45	19.23
85	4	27.59	27.54	22.40	20.39	16.25	19.11
86	1	27.92	27.91	22.66	20.68	16.47	19.27
86	2	28.01	27.88	22.94	20.92	16.59	19.27
86	3	28.03	28.05	22.78	21.00	16.55	19.42
86	4	27.72	27.70	22.77	20.67	16.49	19.35
87	1	27.71	27.70	22.89	20.78	16.65	19.31
87	2	27.29	27.10	24.03	20.43	16.43	16.65
87	3	27.91	27.89	22.84	21.08	16.88	19.44
87	4	27.90	27.85	22.99	20.78	16.71	19.17
94	1	26.93	26.95	22.05	20.17	16.09	18.85
94	2	26.47	25.24	22.54	20.37	15.21	20.19
94	3	27.25	27.19	22.32	20.45	15.96	18.75
94	4	27.69	27.24	22.67	20.45	16.13	18.95
95	1	27.79	27.72	23.10	20.90	16.35	19.29

PT NO	SC	2ND NOZ HUB EXIT STATIC PRESSURE PSIA	2ND ROTOR HUB EXIT STATIC PRESSURE PSIA	DOWN STREAM STATIC PRESSURE PSIA	DOWN STREAM TAYLOR STATIC PRESSURE PSIA	INLET CALORI-METER PRESSURE PSIA	INLET CALORI-METER TEMP DEG F
38	2	7.45	4.87	3.48	4.28	3.74	1186
38	3	7.55	5.14	3.59	4.12	3.86	1185
38	4	7.47	4.69	3.02	3.69	3.27	1187
39	1	7.70	4.98	3.18	4.02	3.39	1184
39	2	7.88	4.85	2.75	3.72	3.05	1180
39	3	7.82	5.02	3.06	4.10	3.29	1181
39	4	7.82	5.22	3.48	4.18	3.70	1187
67	1	12.06	9.75	8.82	9.92	9.12	1315
67	2	11.54	9.24	8.10	9.41	8.31	1299
67	3	11.50	8.65	7.57	9.00	7.88	1286
68	1	11.96	11.49	9.17	11.34	9.36	1323
68	2	13.85	12.12	11.45	13.37	11.58	1359
68	3	11.74	9.18	7.90	9.49	8.06	1287
69	1	12.37	9.95	8.89	9.97	9.06	1307
69	2	11.86	9.36	8.27	9.86	8.47	1295
76	1	10.58	7.05	5.40	6.87	5.69	1243
76	2	10.54	7.09	5.43	7.00	5.73	1245
76	3	10.58	7.15	5.39	6.92	5.69	1247
76	4	10.68	7.05	5.28	6.81	5.56	1243
77	1	10.97	7.29	5.22	6.90	5.52	1243
77	2	10.95	7.27	5.29	6.88	5.10	1243
78	1	10.83	7.21	5.33	6.98	5.67	1238
78	2	10.97	7.53	5.59	7.18	5.79	1240
85	1	10.05	6.50	4.34	5.69	4.59	1218
85	2	10.13	6.38	4.15	2.89	4.47	1214
85	3	10.11	6.28	3.68	5.03	3.98	1205
85	4	9.97	6.11	3.35	4.65	3.61	1193
86	1	10.18	6.24	4.03	5.48	4.27	1205
86	2	10.24	6.44	4.23	5.69	4.45	1213
86	3	10.40	6.42	4.25	3.64	4.55	1214
86	4	10.22	6.32	3.90	5.36	4.18	1208
87	1	10.34	6.68	4.27	5.84	4.59	1215
87	2	9.42	7.09	4.29	5.63	4.77	1216
87	3	10.34	6.36	3.56	5.01	3.90	1200
87	4	10.17	6.34	3.46	4.59	3.74	1192
94	1	9.93	6.05	3.52	4.89	3.72	1190
94	2	11.78	6.05	3.36	4.64	3.68	1191
94	3	10.03	5.99	3.03	4.25	3.37	1181
94	4	10.03	6.15	2.93	4.18	3.37	1176
95	1	10.30	6.36	3.25	3.97	3.74	1185

PT NO	SC	EXIT TEMP DEG F	1ST STAGE HUB REACTION	1ST STAGE TIP REACTION	2ND STAGE HUB REACTION	MAIN TORQUE READING IN-LB	SECONDARY TORQUE READING IN-LB
38	2	1162	0.154	0.541	0.353	466.2	62.7
38	3	1177	0.181	0.584	0.337	482.5	65.4
38	4	1156	0.166	0.553	0.374	461.5	70.7
39	1	1167	0.228	0.575	0.372	400.6	78.5
39	2	1164	0.210	0.547	0.398	394.6	83.3
39	3	1167	0.197	0.566	0.377	391.7	79.9
39	4	1175	0.211	0.586	0.359	410.2	82.1
67	1	1301	0.176	0.547	0.258	495.8	41.6
67	2	1288	0.189	0.560	0.254	521.7	39.9
67	3	1275	0.195	0.571	0.302	540.4	38.8
68	1	1322	0.194	0.606	0.066	465.7	34.0
68	2	1353	0.179	0.555	0.213	319.9	37.3
68	3	1289	0.207	0.551	0.275	485.9	38.7
69	1	1307	0.204	0.554	0.263	429.4	37.7
69	2	1296	0.207	0.578	0.277	398.2	37.6
76	1	1220	0.164	0.564	0.346	605.4	55.7
76	2	1226	0.176	0.572	0.342	536.8	64.0
76	3	1223	0.184	0.572	0.339	626.1	55.0
76	4	1222	0.180	0.553	0.352	587.9	57.3
77	1	1228	0.190	0.568	0.353	602.9	61.5
77	2	1226	0.191	0.556	0.355	597.2	61.4
78	1	1235	0.195	0.534	0.353	560.3	56.9
78	2	1237	0.430	0.650	0.357	564.6	57.2
85	1	1201	0.166	0.568	0.359	542.5	75.6
85	2	1193	0.183	0.571	0.372	622.8	67.4
85	3	1189	0.163	0.562	0.376	638.7	66.7
85	4	1183	0.152	0.546	0.379	631.7	67.1
86	1	1196	0.168	0.552	0.385	566.6	69.9
86	2	1198	0.195	0.566	0.376	560.6	67.2
86	3	1203	0.184	0.547	0.388	538.6	65.9
86	4	1192	0.158	0.558	0.381	601.8	68.0
87	1	1202	0.172	0.552	0.362	600.0	67.2
87	2	1206	0.361	0.665	0.285	577.3	64.7
87	3	1192	0.194	0.542	0.386	572.5	67.0
87	4	1188	0.186	0.558	0.375	571.0	62.2
94	1	1182	0.162	0.548	0.386	603.9	89.2
94	2	1181	0.027	0.646	0.483	640.8	95.3
94	3	1175	0.202	0.569	0.399	609.2	97.0
94	4	1173	0.180	0.583	0.385	640.4	91.9
95	1	1182	0.190	0.587	0.385	637.1	86.3

PT NO	SC	TARE TORQUE READING IN-LB	TOTAL TORQUE READING IN-LB	EMFM FLOW PPS	SPRAY FLOW PPS	TURBINE IDEAL DROP BTU/LB	TURBINE WORK BTU/LB
38	2	105.6	509.1	2.055	0.124	98.5	54.2
38	3	82.1	499.3	2.236	0.150	93.1	40.4
38	4	97.0	487.8	2.296	0.152	99.5	43.7
39	1	98.8	420.8	2.294	0.334	90.8	38.2
39	2	106.6	417.9	2.331	0.336	92.2	39.5
39	3	103.6	415.4	2.460	0.328	92.3	36.4
39	4	100.8	428.9	2.380	0.348	87.9	38.1
67	1	95.1	549.3	2.592	0.119	86.5	43.0
67	2	94.7	576.5	2.536	0.080	91.4	46.0
67	3	103.4	605.0	2.518	0.112	92.8	51.8
68	1	97.5	529.2	2.589	0.193	82.8	42.2
68	2	107.9	390.4	2.606	0.172	70.9	33.3
68	3	95.5	542.7	2.840	0.368	82.2	38.9
69	1	94.0	485.7	2.896	0.426	77.0	33.8
69	2	98.2	458.8	2.887	0.397	79.8	33.0
76	1	102.9	652.6	2.437	0.074	104.2	57.5
76	2	102.2	575.1	2.473	0.127	101.9	49.7
76	3	94.8	665.9	2.424	0.077	104.4	55.6
76	4	102.1	632.8	2.464	0.111	103.9	54.8
77	1	103.4	644.7	2.509	0.209	98.8	55.4
77	2	107.0	642.8	2.505	0.182	100.9	56.7
78	1	93.3	596.7	2.814	0.383	91.1	42.4
78	2	100.2	607.6	2.805	0.391	85.9	45.6
85	1	101.5	568.3	2.471	0.106	105.8	48.9
85	2	97.2	652.6	2.448	0.096	105.2	54.9
85	3	102.3	674.2	2.424	0.075	107.1	59.4
85	4	102.2	666.9	2.410	0.059	108.8	59.1
86	1	104.5	601.2	2.497	0.195	100.7	52.3
86	2	99.4	592.8	2.481	0.173	101.4	50.0
86	3	102.7	575.4	2.491	0.182	102.5	49.9
86	4	102.1	635.8	2.438	0.182	102.7	55.7
87	1	102.1	635.0	2.799	0.374	92.9	48.5
87	2	91.7	604.3	2.794	0.389	88.5	42.8
87	3	100.3	605.8	2.767	0.347	96.4	46.1
87	4	100.4	609.1	2.783	0.362	95.0	46.1
94	1	104.2	618.9	2.427	0.087	106.7	55.3
94	2	101.2	646.7	2.407	0.093	104.8	57.0
94	3	102.5	614.7	2.390	0.064	107.8	55.1
94	4	104.0	652.4	2.416	0.084	106.6	58.4
95	1	97.3	646.1	2.488	0.140	104.0	53.7

PT NO	SC	POWER OUTPUT HP	POWER OUTPUT KW	CORRECTED SPEED RPM	CORRECTED TURBINE WORK BTU/LB	CORRECTED POWER KW	CORRECTED POWER HP
38	2	157	117	19928	56.5	214	288
38	3	127	95	16501	42.2	173	232
38	4	141	105	18743	45.6	192	258
39	1	124	92	19240	41.0	171	230
39	2	130	97	20325	42.3	180	241
39	3	126	94	19872	38.9	174	233
39	4	128	95	19534	40.9	177	237
67	1	157	117	18196	43.5	149	200
67	2	165	123	18104	46.3	155	208
67	3	184	137	19328	52.4	173	233
68	1	154	115	18609	43.1	146	196
68	2	122	91	19991	33.9	116	156
68	3	156	116	18527	40.5	154	207
69	1	138	103	18375	35.4	137	184
69	2	134	100	18930	34.5	135	181
76	1	198	147	19232	58.0	190	254
76	2	173	129	19204	50.5	167	224
76	3	190	142	18121	56.0	180	241
76	4	191	142	19159	55.5	182	244
77	1	196	146	19448	56.7	187	251
77	2	200	149	19902	57.8	191	257
78	1	168	126	18258	44.4	170	228
78	2	181	135	19208	47.7	180	241
85	1	170	127	19104	49.6	169	227
85	2	190	141	18497	55.7	187	250
85	3	203	152	19158	60.0	198	266
85	4	201	150	19143	59.7	199	266
86	1	184	137	19646	53.8	188	253
86	2	175	131	18902	51.3	177	237
86	3	174	130	19357	50.8	175	235
86	4	192	143	19283	57.1	194	260
87	1	191	143	19492	50.8	199	266
87	2	169	126	18059	44.9	174	234
87	3	180	134	19197	48.2	186	250
87	4	181	135	19228	48.3	187	251
94	1	189	141	19469	56.1	194	260
94	2	194	144	19062	57.9	197	264
94	3	186	138	19194	55.7	186	250
94	4	199	148	19426	59.2	199	267
95	1	189	141	18581	54.8	189	253

PT NO	SC	CORRECTED FLOW PPS	1ST STAGE WORK BTU/LB	2ND STAGE WORK BTU/LB	1ST STAGE PERCENT WORK	2ND STAGE PERCENT WORK	TOTAL TO TOTAL EFFICIENCY
38	2	3.602	15.0	39.1	27.75	72.25	0.550
38	3	3.896	11.4	29.0	28.20	71.80	0.434
38	4	4.008	11.8	31.9	26.95	73.05	0.439
39	1	3.978	11.2	27.1	29.22	70.78	0.421
39	2	4.041	10.8	28.7	27.24	72.76	0.428
39	3	4.244	10.4	26.1	28.50	71.50	0.395
39	4	4.112	11.1	27.0	29.06	70.94	0.434
67	1	3.256	14.2	28.7	33.14	66.86	0.497
67	2	3.177	14.7	31.3	32.05	67.95	0.503
67	3	3.144	16.1	35.7	31.01	68.99	0.558
68	1	3.231	16.2	26.1	38.30	61.70	0.510
68	2	3.262	12.4	20.9	37.27	62.73	0.470
68	3	3.621	12.3	26.6	31.67	68.33	0.473
69	1	3.676	11.0	22.8	32.57	67.43	0.438
69	2	3.713	10.8	22.2	32.75	67.25	0.414
76	1	3.104	15.7	41.8	27.33	72.67	0.552
76	2	3.139	13.4	36.2	27.05	72.95	0.492
76	3	3.049	15.2	40.4	27.43	72.57	0.533
76	4	3.112	14.7	40.1	26.82	73.18	0.528
77	1	3.128	14.8	40.6	26.73	73.27	0.560
77	2	3.143	15.3	41.4	27.02	72.98	0.562
78	1	3.640	11.5	30.9	27.10	72.90	0.466
78	2	3.581	13.0	32.7	28.42	71.58	0.531
85	1	3.242	12.9	36.0	26.43	73.57	0.462
85	2	3.184	14.8	40.2	26.87	73.13	0.522
85	3	3.138	15.5	43.9	26.13	73.87	0.555
85	4	3.162	14.9	44.2	25.28	74.72	0.544
86	1	3.324	13.4	38.8	25.69	74.31	0.519
86	2	3.272	13.0	37.0	26.05	73.95	0.494
86	3	3.278	12.7	36.8	25.73	74.27	0.483
86	4	3.223	14.1	41.6	25.24	74.76	0.542
87	1	3.717	12.7	35.8	26.20	73.80	0.522
87	2	3.695	15.9	26.9	37.17	62.83	0.483
87	3	3.671	11.6	34.5	25.15	74.85	0.479
87	4	3.689	12.0	34.1	26.04	73.96	0.486
94	1	3.278	13.7	41.5	24.83	75.17	0.518
94	2	3.226	9.3	47.7	16.26	83.74	0.544
94	3	3.174	14.0	41.0	25.49	74.51	0.511
94	4	3.196	14.8	43.6	25.36	74.64	0.548
95	1	3.266	13.7	40.0	25.53	74.47	0.517

PT NO	SC	TOTAL TO STATIC EFFICIENCY	TURBINE VELOCITY RATIO	EXPANSION EXPONENT
38	2	0.491	0.305	1.382
38	3	0.386	0.259	1.373
38	4	0.389	0.284	1.379
39	1	0.378	0.303	1.291
39	2	0.383	0.317	1.294
39	3	0.356	0.312	1.305
39	4	0.391	0.313	1.290
67	1	0.477	0.313	1.399
67	2	0.482	0.303	1.416
67	3	0.527	0.318	1.398
68	1	0.551	0.345	1.368
68	2	0.451	0.378	1.381
68	3	0.448	0.320	1.304
69	1	0.418	0.327	1.285
69	2	0.393	0.331	1.294
76	1	0.505	0.294	1.414
76	2	0.451	0.298	1.389
76	3	0.492	0.279	1.413
76	4	0.487	0.294	1.397
77	1	0.519	0.305	1.353
77	2	0.523	0.310	1.368
78	1	0.423	0.292	1.294
78	2	0.485	0.318	1.292
85	1	0.426	0.290	1.399
85	2	0.469	0.279	1.403
85	3	0.499	0.286	1.414
85	4	0.489	0.284	1.421
86	1	0.463	0.299	1.356
86	2	0.446	0.289	1.368
86	3	0.439	0.295	1.364
86	4	0.492	0.294	1.364
87	1	0.470	0.308	1.297
87	2	0.437	0.292	1.291
87	3	0.431	0.298	1.308
87	4	0.432	0.298	1.302
94	1	0.467	0.291	1.406
94	2	0.489	0.287	1.403
94	3	0.456	0.285	1.417
94	4	0.494	0.291	1.406
95	1	0.469	0.282	1.380

TABLE VI (Cont'd)

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

Test Date:	Oct. 8, 1964
Nominal Inlet Temperature, °F:	1450, 1550
Nominal Inlet Quality, Percent:	85, 92, 95, 99
Total to Total Pressure Ratio:	2.007 to 4.076

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

DATE	PT NO	SC	TURBINE INLET TEMP DEG F	SPEED RPM	TOTAL TO TOTAL PRESSURE RATIO	TOTAL TO STATIC PRESSURE RATIO	SUPPLIED VAPOR QUALITY	INLET VAPOR QUALITY
1008.64	95	2	1532	18912	3.907	4.524	0.982	0.891
1008.64	95	3	1535	19463	3.854	4.467	0.983	0.897
1008.64	95	4	1536	18176	3.964	4.413	0.983	0.903
1008.64	96	1	1532	19423	3.908	4.598	0.982	0.844
1008.64	96	2	1533	18794	3.889	4.539	0.981	0.839
1008.64	96	3	1530	18160	3.912	4.603	0.981	0.841
1008.64	96	4	1530	18248	3.901	4.594	0.981	0.838
1008.64	103	1	1529	18124	3.948	4.679	0.980	0.926
1008.64	103	2	1522	18768	3.991	4.756	0.980	0.930
1008.64	104	1	1526	18384	3.956	4.691	0.982	0.904
1008.64	104	2	1524	19145	3.922	4.684	0.983	0.915
1008.64	104	3	1531	19065	3.916	4.645	0.983	0.900
1008.64	104	4	1533	19778	3.927	4.629	0.983	0.906
1008.64	105	1	1533	18880	3.901	4.632	0.982	0.890
1008.64	105	2	1528	18071	3.899	4.735	0.985	0.850
1008.64	105	3	1528	18733	3.902	4.668	0.985	0.848
1008.64	105	4	1529	19048	3.929	4.749	0.985	0.848
1008.64	112	1	1546	10729	4.215	4.849	0.979	0.937
1008.64	112	2	1541	18120	4.031	4.798	0.978	0.933
1008.64	112	3	1540	16901	3.705	4.720	0.977	0.925
1008.64	112	4	1540	17733	4.004	4.734	0.978	0.925
1008.64	113	1	1539	19841	4.076	4.847	0.979	0.900
1008.64	113	2	1540	19379	4.059	4.875	0.978	0.915
1008.64	113	3	1539	17334	4.025	4.877	0.979	0.911
1008.64	114	1	1541	17733	3.898	4.377	0.979	0.828
1008.64	114	2	1540	15529	3.877	4.655	0.977	0.835
1008.64	114	3	1541	17745	3.896	4.725	0.977	0.833
1008.64	114	4	1540	18402	3.994	4.768	0.978	0.832
1008.64	1	1	1475	14266	2.194	2.276	0.992	0.992
1008.64	1	2	1472	15798	2.161	2.224	0.992	0.992
1008.64	1	3	1472	15794	2.200	2.262	0.991	0.991
1008.64	1	4	1474	15123	2.183	2.255	0.992	0.992
1008.64	2	1	1473	19119	2.212	2.276	0.992	0.992
1008.64	2	2	1470	14900	2.168	2.225	0.992	0.992
1008.64	2	3	1475	14851	2.152	2.227	0.992	0.992
1008.64	2	4	1477	16660	2.231	2.297	0.992	0.992
1008.64	3	1	1472	18538	2.212	2.284	0.992	0.992
1008.64	3	2	1475	14481	2.174	2.227	0.993	0.993
1008.64	3	3	1469	18423	2.280	2.341	0.993	0.993
1008.64	4	1	1456	17778	2.007	2.057	0.993	0.993

PT NO	SC	EXIT VAPOR QUALITY	SUPPLY TOTAL PRESSURE PSIA	INLET TOTAL PRESSURE PSIA	EXIT TOTAL PRESSURE PSIA	DOWN STREAM TOTAL PRESSURE PSIA	SUPPLY STATIC PRESSURE PSIA
95	2	0.853	29.14	29.12	7.46	3.73	29.00
95	3	0.855	28.78	28.99	7.47	3.64	28.60
95	4	0.864	29.39	29.33	7.41	3.57	29.37
96	1	0.809	28.89	28.91	7.39	3.27	28.73
96	2	0.808	28.70	28.64	7.38	3.26	28.52
96	3	0.808	28.74	28.70	7.35	3.23	28.62
96	4	0.829	28.69	28.55	7.35	3.35	28.65
103	1	0.889	29.04	28.94	7.35	3.13	28.96
103	2	0.892	27.83	27.92	6.97	3.28	27.71
104	1	0.871	28.37	28.26	7.17	2.97	28.22
104	2	0.875	27.69	27.71	7.06	3.13	27.47
104	3	0.858	28.64	28.70	7.32	3.09	28.51
104	4	0.858	28.91	28.65	7.36	2.91	28.93
105	1	0.847	29.20	28.95	7.49	3.08	29.07
105	2	0.817	28.55	28.55	7.32	3.13	28.41
105	3	0.814	28.41	28.09	7.28	3.02	28.41
105	4	0.812	28.53	28.54	7.26	2.94	28.40
112	1	0.923	30.67	30.79	7.28	2.59	30.45
112	2	0.901	29.96	29.87	7.43	2.52	29.97
112	3	0.904	29.75	29.73	8.03	2.63	29.66
112	4	0.895	29.85	29.87	7.45	2.53	29.73
113	1	0.862	29.60	29.72	7.26	2.50	29.28
113	2	0.879	29.77	29.69	7.33	2.49	29.65
113	3	0.884	29.79	29.72	7.40	2.50	29.58
114	1	0.807	29.75	29.58	7.63	2.67	29.66
114	2	0.821	29.71	29.52	7.66	2.55	29.61
114	3	0.812	29.88	29.67	7.67	2.58	29.72
114	4	0.810	29.87	29.73	7.48	2.52	29.81
1	1	0.968	21.97	21.89	10.01	9.37	21.87
1	2	0.960	21.56	21.70	9.97	9.42	21.28
1	3	0.958	22.02	21.62	10.01	9.47	21.98
1	4	0.963	21.90	21.84	10.03	9.40	21.83
2	1	0.955	21.79	21.60	9.85	9.29	21.68
2	2	0.971	21.39	21.36	9.86	9.32	21.24
2	3	0.970	21.85	21.58	10.15	9.58	21.64
2	4	0.972	22.12	21.94	9.92	9.29	22.02
3	1	0.957	21.69	21.61	9.80	9.23	21.56
3	2	0.961	21.93	21.86	10.09	9.44	21.83
3	3	0.958	21.86	21.85	9.59	8.99	21.65
4	1	0.973	19.73	19.77	9.83	9.36	19.60

PT NO	SC	TIP INLET STATIC PRESSURE PSIA	HUB INLET STATIC PRESSURE PSIA	1ST NOZ TIP EXIT STATIC PRESSURE PSIA	1ST NOZ HUB EXIT STATIC PRESSURE PSIA	1ST ROTOR TIP EXIT STATIC PRESSURE PSIA	1ST ROTOR HUB EXIT STATIC PRESSURE PSIA
95	2	28.02	27.91	22.83	21.04	16.63	19.38
95	3	28.47	28.26	23.09	21.16	16.53	19.42
95	4	28.37	28.22	23.02	21.12	16.61	19.40
96	1	27.97	27.82	22.92	21.02	16.80	19.13
96	2	27.87	27.74	22.79	20.98	16.49	18.89
96	3	27.69	27.50	22.52	20.72	16.61	18.99
96	4	27.37	27.35	22.43	20.76	16.55	19.11
103	1	28.08	27.56	22.65	20.72	16.57	19.19
103	2	26.76	26.72	21.57	19.94	15.84	18.58
104	1	27.41	27.20	22.45	20.49	16.15	18.87
104	2	26.62	26.57	21.64	19.98	15.84	18.40
104	3	27.64	27.59	22.70	20.88	16.39	19.19
104	4	28.09	27.73	22.92	20.98	16.45	19.11
105	1	28.10	27.91	23.01	21.22	16.90	19.44
105	2	27.56	27.52	22.35	20.49	16.25	18.81
105	3	27.26	27.06	22.38	20.57	16.23	18.70
105	4	27.47	27.38	22.33	20.67	16.33	18.79
112	1	29.52	29.50	24.46	22.62	17.61	20.55
112	2	28.37	28.54	23.82	22.48	17.43	20.13
112	3	28.65	28.56	25.00	21.93	17.06	18.83
112	4	28.96	28.91	24.17	22.10	17.04	20.00
113	1	28.47	28.49	23.79	21.87	16.98	20.03
113	2	28.49	28.46	23.89	21.75	16.82	19.78
113	3	28.57	28.60	23.86	21.87	16.90	19.76
114	1	28.71	28.65	23.82	22.00	17.14	19.64
114	2	28.54	28.55	23.88	21.89	17.08	19.70
114	3	28.94	28.65	23.90	22.04	17.04	19.64
114	4	28.53	28.54	23.70	22.00	17.02	19.86
1	1	21.26	21.21	18.81	17.16	14.09	15.90
1	2	21.25	21.31	18.36	16.71	14.09	15.86
1	3	20.78	20.65	18.16	16.67	14.09	15.80
1	4	21.13	21.05	18.29	16.88	14.18	16.04
2	1	20.75	20.68	18.06	16.61	13.91	15.84
2	2	20.99	20.74	17.87	16.78	13.97	15.82
2	3	21.13	21.05	18.15	17.06	14.22	16.06
2	4	21.32	21.23	18.43	17.00	14.07	16.09
3	1	21.05	20.98	18.18	17.26	14.16	16.00
3	2	21.28	21.21	18.43	16.92	14.18	15.96
3	3	21.20	21.16	18.24	16.74	13.91	15.80
4	1	19.37	19.24	17.25	15.94	13.44	14.97

PT NO	SC	2ND NOZ HUB EXIT STATIC PRESSURE PSIA	2ND ROTOR HUB EXIT STATIC PRESSURE PSIA	DOWN STREAM STATIC PRESSURE PSIA	DOWN STREAM TAYLOR STATIC PRESSURE PSIA	INLET CALORI- METER PRESSURE PSIA	INLET CALORI- METER TEMP DEG F
95	2	10.22	6.44	3.40	5.05	3.76	1189
95	3	10.32	6.44	3.42	4.61	3.76	1192
95	4	10.32	6.66	3.29	4.59	3.66	1191
96	1	10.18	6.28	3.09	4.36	3.45	1180
96	2	10.24	6.32	3.05	4.19	3.43	1178
96	3	10.13	6.24	2.98	4.34	3.37	1175
96	4	10.24	6.24	3.18	5.19	3.57	1179
103	1	10.05	6.21	2.93	4.16	3.29	1170
103	2	9.79	5.85	3.04	4.25	3.47	1173
104	1	9.91	6.05	2.66	4.06	3.15	1170
104	2	9.75	5.91	2.91	4.31	3.25	1178
104	3	10.13	6.17	2.88	4.19	3.25	1178
104	4	10.11	6.24	2.66	4.10	3.09	1176
105	1	10.30	6.30	2.87	4.16	3.31	1177
105	2	9.99	6.03	2.91	3.34	3.33	1187
105	3	9.93	6.09	2.80	3.39	3.17	1185
105	4	10.09	6.01	2.77	3.73	3.15	1183
112	1	10.34	6.32	2.25	3.51	2.74	1151
112	2	10.11	6.24	2.21	3.56	2.80	1149
112	3	9.81	6.30	2.42	3.63	3.05	1150
112	4	10.15	6.30	2.26	3.48	2.86	1150
113	1	10.03	6.11	2.20	3.51	2.76	1150
113	2	10.09	6.11	2.23	3.07	2.84	1149
113	3	10.20	6.11	2.28	3.47	2.80	1150
114	1	10.18	6.80	2.30	3.52	2.76	1149
114	2	10.30	6.38	2.29	3.56	2.90	1147
114	3	10.28	6.32	2.33	3.57	2.88	1147
114	4	10.48	6.26	2.29	3.38	2.86	1147
1	1	10.70	9.65	9.26	10.24	9.34	1315
1	2	10.36	9.69	9.36	10.24	9.42	1317
1	3	10.40	9.73	9.38	10.28	9.44	1315
1	4	10.54	9.71	9.35	10.34	9.44	1317
2	1	10.48	9.57	9.18	10.00	9.30	1315
2	2	10.38	9.61	9.26	10.14	9.26	1316
2	3	10.64	9.81	9.51	10.44	9.59	1321
2	4	10.74	9.63	9.24	10.48	9.36	1318
3	1	10.42	9.50	9.12	10.46	9.20	1314
3	2	10.70	9.85	9.37	10.36	9.48	1322
3	3	10.22	9.34	8.90	9.89	8.96	1316
4	1	10.42	9.59	9.26	11.01	9.36	1317

PT NO	SC	EXIT TEMP DEG F	1ST STAGE HUB REACTION	1ST STAGE TIP REACTION	2ND STAGE HUB REACTION	MAIN TORQUE READING IN-LB	SECONDARY TORQUE READING IN-LB
95	2	1189	0.196	0.554	0.374	596.9	85.5
95	3	1185	0.212	0.592	0.388	604.7	89.3
95	4	1187	0.198	0.561	0.368	616.2	93.8
96	1	1183	0.223	0.562	0.387	565.5	85.3
96	2	1185	0.244	0.573	0.395	546.7	83.6
96	3	1184	0.205	0.544	0.386	595.2	85.4
96	4	1182	0.199	0.542	0.393	365.9	109.1
103	1	1176	0.181	0.545	0.376	644.2	116.4
103	2	1175	0.170	0.536	0.397	604.6	123.7
104	1	1172	0.196	0.573	0.386	602.5	114.7
104	2	1173	0.196	0.547	0.392	615.9	114.4
104	3	1179	0.206	0.572	0.390	612.0	109.2
104	4	1180	0.220	0.577	0.383	616.2	99.9
105	1	1183	0.209	0.553	0.387	621.1	92.8
105	2	1182	0.199	0.554	0.394	561.6	57.4
105	3	1180	0.222	0.562	0.385	514.5	18.1
105	4	1180	0.221	0.550	0.403	492.6	1.9
112	1	1184	0.233	0.581	0.374	635.6	44.5
112	2	1177	0.270	0.565	0.363	563.4	90.4
112	3	1182	0.324	0.677	0.351	504.0	108.3
112	4	1194	0.244	0.613	0.368	596.3	112.2
113	1	1189	0.219	0.595	0.372	618.8	111.5
113	2	1175	0.226	0.603	0.378	609.5	113.4
113	3	1210	0.241	0.597	0.388	590.2	126.7
114	1	1187	0.267	0.586	0.342	585.1	122.4
114	2	1205	0.250	0.594	0.377	596.4	136.4
114	3	1189	0.268	0.591	0.380	599.6	130.1
114	4	1190	0.245	0.577	0.396	587.7	131.1
1	1	1315	0.231	0.642	0.185	307.9	79.8
1	2	1315	0.166	0.614	0.126	338.1	84.3
1	3	1315	0.157	0.560	0.119	351.4	84.0
1	4	1315	0.162	0.577	0.146	330.3	80.3
2	1	1311	0.145	0.572	0.159	266.5	62.3
2	2	1313	0.192	0.569	0.141	280.1	89.5
2	3	1319	0.193	0.560	0.148	228.1	30.3
2	4	1321	0.168	0.587	0.190	164.3	21.9
3	1	1312	0.244	0.577	0.162	271.3	90.6
3	2	1317	0.181	0.592	0.155	366.0	106.5
3	3	1309	0.175	0.591	0.157	305.7	112.5
4	1	1323	0.222	0.612	0.170	184.6	93.5

PT NO	SC	TARE TORQUE READING IN-LB	TOTAL TORQUE READING IN-LB	EMFM FLOW PPS	SPRAY FLOW PPS	TURBINE IDEAL DROP BTU/LB	TURBINE WORK BTU/LB
95	2	101.2	612.5	2.556	0.217	100.6	50.8
95	3	105.2	620.6	2.542	0.207	100.3	53.3
95	4	95.7	618.2	2.478	0.191	102.9	50.8
96	1	104.9	585.1	2.569	0.347	95.5	49.6
96	2	100.3	563.3	2.581	0.364	94.6	46.0
96	3	95.6	605.4	2.590	0.361	95.2	47.6
96	4	96.2	353.0	2.607	0.369	94.7	27.7
103	1	95.3	623.1	2.605	0.124	105.1	48.6
103	2	100.1	581.0	2.483	0.109	106.0	49.2
104	1	97.2	585.0	2.645	0.196	102.7	45.6
104	2	102.9	604.4	2.551	0.168	103.1	50.9
104	3	102.3	605.1	2.393	0.190	101.7	54.1
104	4	107.6	623.9	2.373	0.177	102.5	58.3
105	1	100.9	629.3	2.431	0.217	100.4	54.8
105	2	94.9	599.1	2.544	0.336	95.9	47.7
105	3	99.8	596.3	2.545	0.342	95.7	49.2
105	4	102.2	592.8	2.520	0.339	96.2	50.2
112	1	51.5	642.5	2.645	0.100	111.2	29.2
112	2	95.3	568.3	2.665	0.109	107.5	43.3
112	3	86.4	482.1	2.676	0.123	100.8	34.2
112	4	92.4	576.5	2.688	0.128	106.2	42.6
113	1	108.0	615.4	2.709	0.202	104.6	50.5
113	2	104.6	600.7	2.687	0.162	106.0	48.6
113	3	89.5	553.0	2.679	0.175	105.0	40.1
114	1	92.4	555.1	2.917	0.433	93.8	37.8
114	2	78.7	538.7	2.909	0.409	94.2	32.3
114	3	92.5	562.0	2.919	0.418	94.3	38.3
114	4	97.4	554.0	2.896	0.418	95.8	39.5
1	1	71.5	299.7	1.714	0.	66.0	28.0
1	2	80.2	334.0	1.708	0.	64.8	34.7
1	3	80.2	347.6	1.718	0.000	66.2	35.8
1	4	76.4	326.4	1.709	0.003	65.6	32.4
2	1	102.7	306.9	1.692	0.004	66.6	38.9
2	2	75.1	265.7	1.706	0.005	65.0	26.0
2	3	74.9	272.6	1.703	0.004	64.5	26.7
2	4	85.1	227.5	1.712	0.009	67.4	24.8
3	1	98.4	279.1	1.552	0.004	66.6	37.4
3	2	72.8	332.3	1.548	0.008	65.4	34.9
3	3	97.5	290.7	1.555	0.007	69.1	38.6
4	1	92.8	183.9	1.539	0.020	58.6	23.8

PT NO	SC	POWER OUTPUT HP	POWER OUTPUT KW	CORRECTED SPEED RPM	CORRECTED TURBINE WORK BTU/LB	CORRECTED POWER KW	CORRECTED POWER HP
95	2	183	137	19210	52.4	188	252
95	3	191	142	19741	54.8	193	258
95	4	178	132	18412	52.2	177	238
96	1	180	134	19902	52.1	190	255
96	2	167	125	19275	48.4	177	238
96	3	174	130	18624	50.1	186	249
96	4	102	76	18726	29.2	109	147
103	1	179	133	18306	49.6	181	243
103	2	173	129	18967	50.3	181	243
104	1	170	127	18650	46.9	178	239
104	2	183	136	19391	52.2	192	257
104	3	183	136	19337	55.6	187	251
104	4	195	146	20036	59.8	198	265
105	1	188	140	19180	56.6	192	258
105	2	171	128	18508	50.1	184	247
105	3	177	132	19191	51.7	190	255
105	4	179	133	19512	52.7	191	257
112	1	109	81	10787	29.5	102	136
112	2	163	121	18247	43.9	156	210
112	3	129	96	17045	34.7	125	167
112	4	162	121	17882	43.4	156	210
113	1	193	144	20099	51.9	191	256
113	2	184	137	19578	49.6	180	241
113	3	152	113	17525	41.0	148	199
114	1	156	116	18202	39.9	160	215
114	2	132	99	15917	33.9	136	182
114	3	158	118	18195	40.3	162	217
114	4	161	120	18874	41.5	166	223
1	1	67	50	14386	28.4	85	114
1	2	83	62	15938	35.3	107	143
1	3	87	64	15935	36.5	111	149
1	4	78	58	15252	32.9	99	133
2	1	93	69	19285	39.6	118	158
2	2	62	46	15035	26.5	81	108
2	3	64	47	14975	27.1	81	108
2	4	60	44	16794	25.2	75	100
3	1	82	61	18701	38.0	104	140
3	2	76	56	14600	35.4	96	129
3	3	84	63	18591	39.3	110	147
4	1	51	38	17982	24.4	71	96

PT NO	SC	CORRECTED FLOW PPS	1ST STAGE WORK BTU/LB	2ND STAGE WORK BTU/LB	1ST STAGE PERCENT WORK	2ND STAGE PERCENT WORK	TOTAL TO TOTAL EFFICIENCY
95	2	3.400	13.1	37.8	25.68	74.32	0.505
95	3	3.338	14.0	39.3	26.31	73.69	0.531
95	4	3.229	13.6	37.3	26.72	73.28	0.494
96	1	3.470	12.9	36.7	26.04	73.96	0.520
96	2	3.485	12.3	33.7	26.76	73.24	0.486
96	3	3.527	12.3	35.3	25.78	74.22	0.500
96	4	3.564	6.8	20.9	24.53	75.47	0.293
103	1	3.474	12.2	36.4	25.04	74.96	0.462
103	2	3.419	12.2	37.1	24.73	75.27	0.465
104	1	3.602	11.4	34.2	25.01	74.99	0.444
104	2	3.491	12.9	38.0	25.30	74.70	0.493
104	3	3.191	13.6	40.4	25.18	74.82	0.532
104	4	3.139	15.2	43.1	26.02	73.98	0.569
105	1	3.231	13.8	41.0	25.24	74.76	0.546
105	2	3.492	12.4	35.4	25.91	74.09	0.498
105	3	3.493	12.6	36.6	25.64	74.36	0.514
105	4	3.446	12.9	37.3	25.72	74.28	0.522
112	1	3.274	6.9	22.3	23.70	76.30	0.263
112	2	3.381	10.2	33.1	23.55	76.45	0.403
112	3	3.417	9.6	24.5	28.14	71.86	0.339
112	4	3.423	10.6	32.1	24.83	75.17	0.402
113	1	3.497	12.0	38.6	23.65	76.35	0.483
113	2	3.442	11.9	36.7	24.40	75.60	0.458
113	3	3.439	9.8	30.3	24.54	75.46	0.382
114	1	3.819	10.1	27.7	26.74	73.26	0.404
114	2	3.805	8.1	24.1	25.17	74.83	0.342
114	3	3.811	9.8	28.5	25.58	74.42	0.406
114	4	3.796	9.7	29.8	24.47	75.53	0.412
1	1	2.851	10.4	17.6	37.02	62.98	0.424
1	2	2.881	13.2	21.4	38.13	61.87	0.535
1	3	2.893	12.9	22.9	36.12	63.88	0.541
1	4	2.855	11.6	20.8	35.68	64.32	0.494
2	1	2.840	13.7	25.2	35.31	64.69	0.584
2	2	2.900	9.3	16.8	35.58	64.42	0.400
2	3	2.836	9.6	17.1	35.84	64.16	0.413
2	4	2.827	8.8	16.1	35.31	64.69	0.368
3	1	2.615	13.0	24.3	34.86	65.14	0.561
3	2	2.577	13.1	21.7	37.68	62.32	0.533
3	3	2.656	14.0	24.6	36.38	63.62	0.559
4	1	2.796	8.7	15.2	36.36	63.64	0.406

PT NO	SC	TOTAL TO STATIC EFFICIENCY	TURBINE VELOCITY RATIO	EXPANSION EXPONENT
95	2	0.461	0.295	1.347
95	3	0.484	0.304	1.353
95	4	0.462	0.284	1.360
96	1	0.470	0.310	1.293
96	2	0.442	0.302	1.288
96	3	0.452	0.290	1.290
96	4	0.264	0.292	1.287
103	1	0.417	0.275	1.387
103	2	0.418	0.284	1.391
104	1	0.400	0.282	1.362
104	2	0.442	0.293	1.374
104	3	0.479	0.294	1.357
104	4	0.514	0.305	1.364
105	1	0.491	0.293	1.346
105	2	0.442	0.285	1.301
105	3	0.460	0.297	1.299
105	4	0.465	0.301	1.298
112	1	0.242	0.160	1.398
112	2	0.363	0.272	1.394
112	3	0.291	0.256	1.385
112	4	0.363	0.268	1.385
113	1	0.436	0.302	1.357
113	2	0.411	0.292	1.374
113	3	0.341	0.262	1.369
114	1	0.375	0.290	1.275
114	2	0.306	0.248	1.284
114	3	0.361	0.282	1.281
114	4	0.370	0.292	1.280
1	1	0.406	0.282	1.462
1	2	0.517	0.316	1.463
1	3	0.524	0.313	1.462
1	4	0.475	0.300	1.463
2	1	0.565	0.378	1.463
2	2	0.388	0.298	1.464
2	3	0.397	0.297	1.463
2	4	0.356	0.327	1.463
3	1	0.541	0.366	1.463
3	2	0.518	0.290	1.464
3	3	0.543	0.358	1.465
4	1	0.393	0.375	1.465

TABLE VI (Cont'd)

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

Test Date:	Oct. 8, 1964
Nominal Inlet Temperature, °F:	1450
Nominal Inlet Quality, Percent:	99
Total to Total Pressure Ratio:	1.893 to 3.814

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

DATE	PT NO	SC	TURBINE INLET TEMP DEG F	SPEED RPM	TOTAL TO TOTAL PRESSURE RATIO	TOTAL TO STATIC PRESSURE RATIO	SUPPLIED VAPOR QUALITY	INLET VAPOR QUALITY
1008.64	4	2	1464	18460	1.968	2.025	0.993	0.993
1008.64	4	3	1450	19425	2.036	2.087	0.993	0.993
1008.64	4	4	1461	18438	1.893	1.891	0.995	0.995
1008.64	11	1	1459	16430	3.070	3.302	0.986	0.986
1008.64	11	2	1461	15441	2.909	3.191	0.986	0.986
1008.64	11	3	1461	15386	2.882	3.178	0.986	0.986
1008.64	11	4	1463	16241	2.860	3.136	0.986	0.986
1008.64	12	1	1474	17527	3.111	3.501	0.984	0.984
1008.64	12	2	1475	17168	3.017	3.325	0.986	0.986
1008.64	12	3	1474	17897	3.133	3.450	0.986	0.986
1008.64	13	1	1476	17412	3.139	3.365	0.986	0.986
1008.64	13	2	1476	19088	3.120	3.432	0.985	0.985
1008.64	13	3	1477	16752	3.145	3.510	0.986	0.986
1008.64	13	4	1479	17082	3.105	3.431	0.986	0.986
1008.64	14	1	1482	19468	3.150	3.486	0.986	0.986
1008.64	14	2	1484	18610	3.238	3.457	0.985	0.985
1008.64	14	3	1481	19698	3.360	3.646	0.985	0.985
1008.64	21	1	1469	15652	3.434	4.112	0.987	0.987
1008.64	21	2	1469	16099	3.451	4.188	0.987	0.987
1008.64	21	3	1469	15778	3.416	4.084	0.986	0.986
1008.64	21	4	1469	15870	3.374	4.049	0.985	0.985
1008.64	22	1	1470	17984	3.629	4.286	0.984	0.984
1008.64	22	2	1473	17036	3.371	3.906	0.985	0.985
1008.64	22	3	1475	16615	3.498	4.101	0.986	0.986
1008.64	22	4	1475	17838	3.588	4.142	0.985	0.985
1008.64	23	1	1467	17886	3.547	4.107	0.984	0.984
1008.64	23	2	1465	17348	3.498	4.088	0.986	0.986
1008.64	23	3	1464	18319	3.484	4.060	0.985	0.985
1008.64	23	4	1461	17969	3.416	3.953	0.987	0.987
1008.64	24	1	1469	19097	3.574	4.082	0.986	0.986
1008.64	24	2	1466	18521	3.707	4.385	0.989	0.989
1008.64	24	3	1464	20163	3.479	3.970	0.984	0.984
1008.64	24	4	1459	20654	3.541	3.960	0.988	0.988
1008.64	33	1	1472	17693	3.736	4.601	0.987	0.987
1008.64	33	2	1472	17373	3.645	4.529	0.988	0.988
1008.64	33	3	1475	16803	3.690	4.448	0.988	0.988
1008.64	33	4	1477	17203	3.623	4.435	0.988	0.988
1008.64	34	1	1483	19909	3.814	4.575	0.989	0.989
1008.64	34	2	1485	19701	3.789	4.508	0.987	0.987
1008.64	34	3	1490	20525	3.805	4.545	0.987	0.987

PT SC NO	EXIT VAPOR QUALITY	SUPPLY TOTAL PRESSURE PSIA	INLET TOTAL PRESSURE PSIA	EXIT TOTAL PRESSURE PSIA	DOWN STREAM TOTAL PRESSURE PSIA	SUPPLY STATIC PRESSURE PSIA
4 2	0.968	20.06	20.17	10.19	9.61	19.96
4 3	0.970	19.32	19.39	9.49	8.98	19.18
4 4	0.970	20.64	20.78	10.90	10.72	19.83
11 1	0.937	20.68	20.46	6.74	5.65	20.58
11 2	0.944	20.74	20.61	7.13	6.02	20.56
11 3	0.946	20.47	20.43	7.11	6.07	20.31
11 4	0.948	20.70	20.74	7.24	6.25	20.56
12 1	0.943	21.86	21.76	7.03	5.71	21.76
12 2	0.946	22.01	22.00	7.30	6.17	21.88
12 3	0.956	21.75	21.84	6.94	5.74	21.56
13 1	0.948	22.01	21.83	7.01	5.99	22.00
13 2	0.932	21.84	22.03	7.00	5.83	21.56
13 3	0.941	22.06	21.98	7.01	5.88	21.91
13 4	0.945	22.31	22.22	7.18	5.99	22.17
14 1	0.935	22.32	22.39	7.09	5.80	22.12
14 2	0.943	22.81	22.62	7.05	5.86	22.81
14 3	0.935	22.84	22.65	6.80	5.50	22.76
21 1	0.941	21.47	21.25	6.25	4.33	21.33
21 2	0.938	21.37	21.52	6.19	4.25	21.15
21 3	0.939	21.40	21.51	6.26	4.19	21.13
21 4	0.936	21.54	21.43	6.38	4.60	21.38
22 1	0.936	21.78	21.58	6.00	4.24	21.66
22 2	0.941	21.62	21.61	6.42	4.61	21.48
22 3	0.942	22.22	21.71	6.35	4.47	21.98
22 4	0.936	22.03	22.02	6.14	4.24	21.91
23 1	0.934	21.52	21.39	6.07	4.52	21.44
23 2	0.940	20.70	20.97	5.92	4.37	20.37
23 3	0.936	20.80	20.85	5.97	4.26	20.60
23 4	0.942	20.64	20.65	6.04	4.45	20.49
24 1	0.943	21.31	21.35	5.96	4.34	21.00
24 2	0.941	21.25	21.21	5.73	3.89	21.12
24 3	0.948	20.88	20.82	6.00	4.43	20.75
24 4	0.944	20.67	20.70	5.84	4.34	20.41
33 1	0.942	21.93	21.85	5.87	3.43	21.81
33 2	0.941	21.59	21.66	5.92	3.23	21.47
33 3	0.943	21.91	21.91	5.94	3.34	21.85
33 4	0.944	21.84	22.00	6.03	3.52	21.55
34 1	0.937	22.89	22.71	6.00	3.10	22.79
34 2	0.942	23.09	23.06	6.09	3.39	22.89
34 3	0.935	23.64	23.55	6.2[illegible]	3.22	23.46

PT NO	SC	TIP INLET STATIC PRESSURE PSIA	HUB INLET STATIC PRESSURE PSIA	1ST NOZ TIP EXIT STATIC PRESSURE PSIA	1ST NOZ HUB EXIT STATIC PRESSURE PSIA	1ST ROTOR TIP EXIT STATIC PRESSURE PSIA	1ST ROTOR HUB EXIT STATIC PRESSURE PSIA
4	2	21.52	21.37	18.54	17.99	13.89	15.62
4	3	18.76	18.73	16.50	15.27	12.75	15.11
4	4	20.13	20.11	17.55	16.27	14.16	15.70
11	1	19.70	19.65	16.08	14.40	11.66	13.71
11	2	19.78	19.78	16.41	14.70	11.86	13.89
11	3	19.63	19.64	16.25	14.77	11.86	13.99
11	4	19.97	20.00	16.58	14.91	11.94	14.11
12	1	21.11	20.99	17.67	15.90	12.55	14.64
12	2	21.05	21.06	17.44	15.66	12.41	14.79
12	3	21.11	21.07	17.24	15.76	12.49	14.85
13	1	21.41	21.27	17.54	15.88	12.73	14.89
13	2	21.20	21.28	17.74	16.19	12.80	15.09
13	3	21.28	21.17	17.59	16.21	12.84	15.03
13	4	21.70	21.50	17.90	16.29	13.02	15.09
14	1	22.06	21.94	18.47	16.74	13.20	15.37
14	2	22.23	22.05	18.35	16.82	13.22	15.46
14	3	21.72	21.58	18.25	16.74	13.20	15.44
21	1	20.75	20.46	16.45	14.89	11.96	14.03
21	2	20.70	20.60	16.45	14.52	11.60	13.91
21	3	20.53	20.53	16.40	14.60	11.60	13.91
21	4	20.78	20.65	16.42	14.87	11.84	14.09
22	1	20.86	20.60	16.93	15.39	12.10	14.24
22	2	21.06	20.96	16.77	14.93	11.86	14.01
22	3	21.18	20.98	17.27	15.37	12.04	14.32
22	4	21.24	21.07	17.14	15.50	12.14	14.54
23	1	20.54	20.37	16.65	14.97	11.88	14.05
23	2	20.29	20.26	16.23	14.66	11.60	13.75
23	3	19.91	19.83	16.15	14.38	11.50	13.63
23	4	20.01	19.92	16.13	14.42	11.47	13.44
24	1	20.43	20.38	16.76	15.50	12.00	14.12
24	2	20.18	20.24	16.51	14.91	11.49	13.89
24	3	20.11	20.00	16.44	14.74	11.56	13.69
24	4	20.12	20.01	16.09	14.48	11.43	13.49
33	1	21.06	20.80	16.61	14.81	11.62	13.91
33	2	20.76	20.67	16.39	14.77	11.47	13.83
33	3	21.10	20.96	16.71	14.93	11.82	14.18
33	4	21.45	21.45	17.00	15.13	11.82	14.22
34	1	21.95	21.81	17.45	15.68	12.14	14.66
34	2	22.06	22.04	17.49	15.84	12.25	14.77
34	3	22.50	22.38	17.99	16.15	12.49	15.09

PT NO	SC	2ND NOZ HUB EXIT STATIC PRESSURE PSIA	2ND ROTOR HUB EXIT STATIC PRESSURE PSIA	DOWN STREAM STATIC PRESSURE PSIA	DOWN STREAM TAYLOR STATIC PRESSURE PSIA	INLET CALORI-METER PRESSURE PSIA	INLET CALORI-METER TEMP DEG F
4	2	10.78	9.91	9.57	10.51	9.65	1322
4	3	10.70	9.26	8.90	9.89	9.00	1309
4	4	11.31	10.91	10.56	10.28	10.74	1343
11	1	7.33	6.26	5.58	6.72	5.75	1215
11	2	7.66	6.50	5.94	6.90	6.03	1222
11	3	8.06	6.44	5.91	6.97	6.11	1221
11	4	8.12	6.60	6.07	6.99	6.11	1218
12	1	8.08	6.24	5.56	6.71	5.61	1225
12	2	8.33	6.62	5.98	6.98	6.11	1233
12	3	8.33	6.30	5.71	6.53	5.87	1238
13	1	7.98	6.54	5.89	6.95	6.01	1233
13	2	8.31	6.36	5.70	6.67	5.87	1232
13	3	8.00	6.28	5.69	6.91	5.91	1229
13	4	8.16	6.50	5.87	6.90	5.99	1231
14	1	8.08	6.40	5.67	6.99	5.75	1236
14	2	8.23	6.60	5.77	6.70	5.95	1238
14	3	8.06	6.26	5.41	6.32	5.56	1231
21	1	7.43	5.22	4.20	4.97	4.43	1209
21	2	7.43	5.10	4.06	4.86	4.35	1206
21	3	7.39	5.24	4.05	4.92	4.26	1202
21	4	7.55	5.32	4.39	5.05	4.63	1206
22	1	7.58	5.08	4.09	5.02	4.27	1197
22	2	7.43	5.54	4.48	5.34	4.63	1207
22	3	7.78	5.42	4.29	5.26	4.51	1210
22	4	7.72	5.32	4.13	4.84	4.39	1204
23	1	7.39	5.24	4.34	5.23	4.51	1201
23	2	7.21	5.06	4.28	4.95	4.43	1203
23	3	7.07	5.12	4.18	5.13	4.39	1201
23	4	7.09	5.22	4.35	5.38	4.51	1210
24	1	7.56	5.22	4.23	4.93	4.53	1208
24	2	7.53	4.85	3.69	4.81	3.72	1200
24	3	7.25	5.26	4.30	5.53	4.39	1197
24	4	7.07	5.22	4.23	4.80	4.37	1210
33	1	7.53	4.77	3.25	3.96	3.59	1190
33	2	7.45	4.77	2.97	3.81	3.27	1188
33	3	7.56	4.92	3.07	3.89	3.39	1188
33	4	7.68	4.92	2.99	4.22	3.59	1193
34	1	7.76	5.00	2.88	3.86	3.15	1189
34	2	7.96	5.12	3.21	4.02	3.55	1193
34	3	8.20	5.20	2.99	3.89	3.31	1190

PT NO	SC	EXIT TEMP DEG F	1ST STAGE HUB REACTION	1ST STAGE TIP REACTION	2ND STAGE HUB REACTION	MAIN TORQUE READING IN-LB	SECONDARY TORQUE READING IN-LB
4	2	1318	0.558	0.780	0.191	187.7	78.0
4	3	1306	0.041	0.612	0.270	181.2	94.8
4	4	1323	0.128	0.562	0.091	185.2	86.6
11	1	1229	0.116	0.548	0.176	454.1	48.0
11	2	1238	0.137	0.569	0.190	437.7	53.2
11	3	1239	0.140	0.566	0.256	418.6	50.0
11	4	1242	0.141	0.585	0.243	441.9	123.6
12	1	1229	0.201	0.606	0.267	475.8	109.5
12	2	1240	0.139	0.583	0.253	473.5	106.1
12	3	1231	0.151	0.570	0.293	377.1	111.1
13	1	1237	0.159	0.575	0.217	370.2	20.8
13	2	1230	0.166	0.600	0.279	458.6	46.0
13	3	1232	0.192	0.571	0.245	477.9	62.4
13	4	1235	0.191	0.580	0.240	424.6	70.3
14	1	1233	0.225	0.629	0.240	432.0	101.2
14	2	1232	0.211	0.590	0.234	423.1	117.3
14	3	1223	0.201	0.580	0.246	438.2	102.4
21	1	1187	0.137	0.533	0.311	499.4	34.4
21	2	1182	0.097	0.559	0.328	511.1	33.0
21	3	1184	0.109	0.553	0.308	513.1	32.0
21	4	1191	0.124	0.534	0.314	526.3	31.6
22	1	1186	0.176	0.560	0.339	460.5	48.6
22	2	1200	0.143	0.565	0.289	455.2	48.8
22	3	1197	0.155	0.576	0.324	470.6	48.5
22	4	1186	0.150	0.567	0.328	463.4	44.3
23	1	1187	0.145	0.556	0.304	488.3	50.4
23	2	1183	0.152	0.568	0.317	473.3	60.4
23	3	1185	0.123	0.561	0.289	474.5	74.2
23	4	1188	0.160	0.569	0.286	467.5	57.7
24	1	1184	0.221	0.571	0.330	408.4	65.9
24	2	1174	0.162	0.577	0.368	473.5	63.4
24	3	1194	0.169	0.583	0.296	340.5	83.5
24	4	1188	0.160	0.566	0.286	432.1	69.4
33	1	1162	0.134	0.549	0.371	454.0	41.0
33	2	1158	0.144	0.552	0.365	474.0	34.9
33	3	1162	0.115	0.548	0.356	480.8	40.9
33	4	1167	0.140	0.580	0.374	460.0	40.5
34	1	1159	0.147	0.560	0.358	468.2	29.3
34	2	1163	0.151	0.549	0.366	473.5	39.1
34	3	1164	0.147	0.558	0.373	491.7	38.4

PT NO	SC	TARE TORQUE READING IN-LB	TOTAL TORQUE READING IN-LB	EMFM FLOW PPS	SPRAY FLOW PPS	TURBINE IDEAL DROP BTU/LB	TURBINE WORK BTU/LB
4	2	97.8	207.5	1.524	0.008	57.1	28.2
4	3	105.0	191.4	1.583	0.004	59.6	26.3
4	4	97.6	196.3	1.509	0.006	54.2	26.9
11	1	83.8	489.9	1.677	0.012	90.9	53.8
11	2	78.2	462.8	1.699	0.010	86.9	47.2
11	3	77.9	446.5	1.702	0.014	86.1	45.3
11	4	82.7	401.1	1.691	0.010	85.6	43.2
12	1	90.9	457.3	1.928	0.010	92.0	46.6
12	2	88.3	455.7	1.923	0.007	90.0	45.6
12	3	93.6	359.7	1.922	0.012	92.7	37.5
13	1	90.1	439.4	1.939	0.012	92.9	44.3
13	2	102.5	515.1	1.932	0.013	92.3	57.1
13	3	85.6	501.2	1.860	0.010	93.1	50.6
13	4	87.6	441.9	1.822	0.014	92.2	46.5
14	1	105.3	436.0	1.718	0.013	93.3	55.4
14	2	98.9	404.7	1.739	0.013	95.4	48.6
14	3	107.0	442.8	1.747	0.015	98.1	56.0
21	1	79.4	544.3	1.827	0.	99.4	52.3
21	2	81.9	560.0	1.862	0.025	99.7	54.3
21	3	80.1	561.2	1.854	0.003	99.0	53.6
21	4	80.6	575.3	1.866	0.002	98.0	54.9
22	1	94.3	506.2	1.868	0.006	103.3	54.6
22	2	87.3	493.7	1.869	0.004	97.9	50.5
22	3	84.8	506.9	1.867	0.007	100.9	50.6
22	4	93.2	512.3	1.848	0.008	102.6	55.5
23	1	93.6	531.5	1.895	0.009	101.5	56.2
23	2	89.6	502.5	1.889	0.008	100.4	51.8
23	3	96.8	497.1	1.861	0.007	100.1	54.9
23	4	94.2	504.0	1.962	0.009	98.8	51.8
24	1	102.5	445.0	1.917	0.007	102.2	49.7
24	2	98.3	508.3	1.950	0.011	105.1	54.1
24	3	110.4	367.3	1.901	0.010	99.9	43.7
24	4	114.0	476.8	2.169	0.013	101.5	50.9
33	1	92.1	505.1	1.934	0.016	105.7	51.8
33	2	89.8	528.9	1.921	0.016	104.0	53.6
33	3	85.9	525.8	1.910	0.015	104.9	51.9
33	4	88.5	508.0	1.917	0.015	103.5	51.1
34	1	108.5	547.4	2.096	0.014	107.7	58.3
34	2	107.0	541.4	2.280	0.013	107.1	52.5
34	3	113.1	566.3	2.229	0.013	107.6	58.5

PT NO	SC	POWER OUTPUT HP	POWER OUTPUT KW	CORRECTED SPEED RPM	CORRECTED TURBINE WORK BTU/LB	CORRECTED POWER KW	CORRECTED POWER HP
4	2	60	45	18645	28.7	80	108
4	3	58	44	19672	27.0	84	113
4	4	57	42	18629	27.4	77	103
11	1	127	95	16628	55.1	174	234
11	2	113	84	15621	48.3	153	205
11	3	109	81	15567	46.3	147	198
11	4	103	77	16426	44.2	138	186
12	1	127	94	17699	47.5	162	217
12	2	124	92	17328	46.5	157	210
12	3	102	76	18067	38.3	130	174
13	1	121	90	17572	45.1	153	205
13	2	156	116	19265	58.1	196	263
13	3	133	99	16903	51.5	167	224
13	4	119	89	17230	47.3	148	199
14	1	134	100	19624	56.3	164	220
14	2	119	89	18757	49.3	145	194
14	3	138	103	19864	56.9	170	228
21	1	135	100	15811	53.3	175	235
21	2	143	106	16264	55.4	186	249
21	3	140	104	15940	54.7	183	245
21	4	144	108	16038	56.0	189	253
22	1	144	107	18172	55.8	188	252
22	2	133	99	17203	51.5	170	228
22	3	133	99	16769	51.5	169	226
22	4	145	108	18006	56.5	183	246
23	1	150	112	18082	57.5	198	266
23	2	138	103	17542	52.9	184	247
23	3	144	107	18526	56.1	193	258
23	4	143	107	18177	53.0	194	261
24	1	134	100	19295	50.8	176	235
24	2	149	111	18715	55.3	197	265
24	3	117	87	20397	44.7	157	211
24	4	156	116	20897	52.1	213	286
33	1	141	105	17865	52.8	182	244
33	2	145	108	17537	54.7	187	250
33	3	140	104	16955	52.8	177	237
33	4	138	103	17353	52.0	173	233
34	1	172	128	20058	59.2	210	282
34	2	169	126	19845	53.2	203	273
34	3	184	137	20658	59.2	217	291

PT NO	SC	CORRECTED FLOW PPS	1ST STAGE WORK BTU/LB	2ND STAGE WORK BTU/LB	1ST STAGE PERCENT WORK	2ND STAGE PERCENT WORK	TOTAL TO TOTAL EFFICIENCY
4	2	2.666	11.7	16.5	41.46	58.54	0.493
4	3	2.961	8.1	18.2	30.86	69.14	0.442
4	4	2.676	11.0	15.9	40.92	59.08	0.496
11	1	3.004	17.5	36.4	32.46	67.54	0.592
11	2	3.014	15.4	31.8	32.64	67.36	0.543
11	3	3.025	14.1	31.1	31.27	68.73	0.526
11	4	2.979	13.9	29.3	32.26	67.74	0.505
12	1	3.235	14.3	32.4	30.58	69.42	0.506
12	2	3.208	14.3	31.3	31.30	68.70	0.507
12	3	3.227	11.1	26.5	29.54	70.46	0.405
13	1	3.223	13.7	30.6	30.92	69.08	0.476
13	2	3.203	16.9	40.2	29.54	70.46	0.618
13	3	3.077	14.7	35.9	29.09	70.91	0.544
13	4	2.987	14.1	32.3	30.41	69.59	0.504
14	1	2.770	16.6	38.8	29.97	70.03	0.594
14	2	2.790	14.7	33.9	30.21	69.79	0.509
14	3	2.840	15.6	40.3	27.96	72.04	0.570
21	1	3.126	15.0	37.3	28.63	71.37	0.526
21	2	3.187	15.9	38.4	29.24	70.76	0.545
21	3	3.174	15.8	37.7	29.57	70.43	0.541
21	4	3.203	16.1	38.8	29.29	70.71	0.560
22	1	3.194	14.9	39.7	27.33	72.67	0.529
22	2	3.144	15.8	34.7	31.26	68.74	0.515
22	3	3.113	14.7	35.9	29.10	70.90	0.501
22	4	3.083	15.5	40.0	27.94	72.06	0.540
23	1	3.278	16.0	40.3	28.39	71.61	0.554
23	2	3.301	15.0	36.8	28.94	71.06	0.515
23	3	3.259	15.7	39.1	28.70	71.30	0.548
23	4	3.484	15.7	36.0	30.39	69.61	0.524
24	1	3.285	13.8	35.9	27.75	72.25	0.487
24	2	3.388	14.8	39.4	27.31	72.69	0.515
24	3	3.341	12.7	31.0	29.08	70.92	0.437
24	4	3.881	15.4	35.5	30.21	69.79	0.502
33	1	3.270	14.7	37.2	28.31	71.69	0.490
33	2	3.244	15.3	38.4	28.45	71.55	0.516
33	3	3.185	14.5	37.4	27.92	72.08	0.495
33	4	3.168	14.8	36.3	28.96	71.04	0.494
34	1	3.373	16.4	41.9	28.08	71.92	0.541
34	2	3.628	14.9	37.6	28.36	71.64	0.490
34	3	3.474	16.4	42.1	28.08	71.92	0.54[illegible]

PT NO	SC	TOTAL TO STATIC EFFICIENCY	TURBINE VELOCITY RATIO	EXPANSION EXPONENT
4	2	0.475	0.393	1.465
4	3	0.428	C.406	1.465
4	4	0.497	0.411	1.467
11	1	0.559	0.275	1.457
11	2	0.503	0.262	1.457
11	3	0.485	0.261	1.457
11	4	0.467	0.277	1.457
12	1	0.463	0.287	1.454
12	2	0.470	0.286	1.456
12	3	0.376	0.294	1.456
13	1	0.451	0.288	1.456
13	2	0.575	0.314	1.454
13	3	0.501	0.273	1.456
13	4	0.467	0.281	1.456
14	1	0.550	0.318	1.456
14	2	0.485	0.305	1.455
14	3	0.538	0.317	1.455
21	1	0.465	0.242	1.457
21	2	0.478	0.248	1.457
21	3	0.479	0.245	1.457
21	4	0.494	0.247	1.455
22	1	0.474	0.275	1.455
22	2	0.465	0.268	1.455
22	3	0.450	0.257	1.456
22	4	0.491	0.275	1.455
23	1	0.502	0.277	1.454
23	2	0.464	0.269	1.456
23	3	0.494	0.285	1.456
23	4	0.474	0.282	1.458
24	1	0.445	0.296	1.456
24	2	0.463	0.281	1.460
24	3	0.399	0.316	1.455
24	4	0.465	0.324	1.459
33	1	0.430	0.264	1.457
33	2	0.449	0.261	1.459
33	3	0.439	0.254	1.458
33	4	0.434	0.260	1.458
34	1	0.483	0.297	1.459
34	2	0.439	0.296	1.457
34	3	0.486	0.307	1.457

TABLE VI (Cont'd)

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

Test Date:	Oct. 8, 1964
Nominal Inlet Temperature, °F:	1450, 1550
Nominal Inlet Quality, Percent:	99
Total to Total Pressure Ratio:	2.092 to 3.930

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

DATE	PT NO	SC	TURBINE INLET TEMP DEG F	SPEED RPM	TOTAL TO TOTAL PRESSURE RATIO	TOTAL TO STATIC PRESSURE RATIO	SUPPLIED VAPOR QUALITY	INLET VAPOR QUALITY
1008.64	34	4	1491	19953	3.726	4.472	0.987	0.987
1008.64	130	1	1494	15936	3.930	5.034	0.991	0.991
1008.64	132	1	1481	20126	3.689	4.383	0.987	0.987
1008.64	132	2	1483	18273	3.687	4.355	0.989	0.989
1008.64	132	3	1483	18273	3.687	4.355	0.989	0.989
1008.64	133	1	1470	15816	3.458	3.994	0.985	0.985
1008.64	133	2	1472	15330	3.469	4.255	0.986	0.986
1008.64	133	3	1472	16127	3.628	4.278	0.986	0.986
1008.64	133	4	1471	16654	3.410	4.051	0.983	0.983
1008.64	134	1	1479	18792	3.509	4.026	0.984	0.984
1008.64	134	2	1484	19173	3.628	4.356	0.985	0.985
1008.64	134	3	1483	18669	3.755	4.248	0.986	0.986
1008.64	134	4	1484	18130	3.657	4.182	0.985	0.985
1008.64	135	1	1466	16581	3.155	3.508	0.986	0.986
1008.64	135	2	1466	15723	3.058	3.338	0.986	0.986
1008.64	135	3	1468	15899	2.965	3.205	0.986	0.986
1008.64	135	4	1466	16249	2.913	3.146	0.986	0.986
1008.64	136	1	1480	19782	3.173	3.427	0.986	0.986
1008.64	136	2	1479	18676	3.117	3.343	0.986	0.986
1008.64	136	3	1478	14947	3.204	3.520	0.986	0.986
1008.64	136	4	1476	14631	3.293	3.723	0.989	0.989
1008.64	137	1	1471	15153	2.155	2.199	0.992	0.992
1008.64	137	2	1475	16077	2.191	2.269	0.991	0.991
1008.64	137	3	1474	13832	2.241	2.294	0.992	0.992
1008.64	138	1	1462	18645	2.092	2.163	0.993	0.993
1008.64	138	2	1464	19266	2.136	2.200	0.994	0.994
1008.64	138	3	1463	20694	2.192	2.269	0.993	0.993
1008.64	138	4	1467	20000	2.144	2.191	0.993	0.993
1008.64	61	1	1543	14894	3.097	3.520	0.985	0.985
1008.64	61	2	1541	14794	3.044	3.326	0.986	0.986
1008.64	61	3	1541	15299	3.033	3.330	0.986	0.986
1008.64	61	4	1538	15309	2.955	3.203	0.986	0.986
1008.64	62	1	1537	17558	2.956	3.208	0.987	0.987
1008.64	62	2	1537	17064	3.045	3.352	0.988	0.988
1008.64	62	3	1536	14170	2.953	3.119	0.988	0.988
1008.64	62	4	1538	17293	2.946	3.102	0.989	0.989
1008.64	63	1	1537	18610	3.004	3.175	0.989	0.989
1008.64	63	2	1538	18424	2.9[illegible]3	3.074	0.989	0.989
1008.64	63	3	1539	17543	3.061	3.393	0.991	0.991
1008.64	63	4	1537	18058	3.120	3.399	0.990	0.990

PT NO	SC	EXIT VAPOR QUALITY	SUPPLY TOTAL PRESSURE PSIA	INLET TOTAL PRESSURE PSIA	EXIT TOTAL PRESSURE PSIA	DOWN STREAM TOTAL PRESSURE PSIA	SUPPLY STATIC PRESSURE PSIA
34	4	0.931	23.78	23.56	6.38	3.20	23.58
130	1	0.934	22.12	22.08	5.63	1.86	22.02
132	1	0.936	22.79	22.60	6.18	3.53	22.67
132	2	0.942	22.90	22.69	6.21	3.80	22.82
132	3	0.942	22.90	22.69	6.21	3.80	22.82
133	1	0.942	21.64	21.58	6.26	4.40	21.54
133	2	0.940	21.46	21.51	6.19	4.10	21.31
133	3	0.942	21.66	21.49	5.97	3.99	21.52
133	4	0.939	21.79	21.66	6.39	4.50	21.62
134	1	0.940	22.05	22.03	6.28	4.41	21.87
134	2	0.932	22.65	22.65	6.24	4.24	22.50
134	3	0.942	22.93	22.94	6.11	3.91	22.71
134	4	0.941	22.98	22.71	6.28	4.19	22.90
135	1	0.943	21.22	21.15	6.72	5.61	21.04
135	2	0.947	20.84	20.69	6.82	5.68	20.73
135	3	0.949	21.03	21.01	7.09	5.89	20.79
135	4	0.944	21.20	21.21	7.28	6.19	20.93
136	1	0.942	22.48	22.39	7.09	5.86	22.31
136	2	0.939	22.39	22.39	7.18	6.17	22.28
136	3	0.943	22.05	22.20	6.88	5.69	21.87
136	4	0.953	22.08	21.83	6.70	5.32	21.98
137	1	0.964	21.75	21.54	10.09	9.58	21.69
137	2	0.962	21.85	21.81	9.97	9.38	21.60
137	3	0.965	22.01	21.79	9.82	9.27	21.92
138	1	0.969	20.53	20.56	9.82	9.25	20.39
138	2	0.968	20.67	20.70	9.68	9.12	20.37
138	3	0.963	20.74	21.15	9.46	8.81	20.18
138	4	0.965	21.15	21.01	9.86	9.32	20.97
61	1	0.940	30.51	30.11	9.85	7.99	30.33
61	2	0.942	30.40	30.26	9.99	8.41	30.32
61	3	0.941	29.85	29.78	9.84	8.18	29.76
61	4	0.940	29.90	29.85	10.12	8.58	29.89
62	1	0.936	29.64	29.66	10.03	8.65	29.45
62	2	0.938	29.25	29.37	9.61	8.08	29.08
62	3	0.954	29.56	29.50	10.01	8.58	29.37
62	4	0.943	29.64	29.66	10.06	8.76	29.53
63	1	0.940	29.59	29.62	9.85	8.43	29.43
63	2	0.943	29.73	29.87	10.24	8.96	29.54
63	3	0.946	29.74	29.48	9.41	7.85	29.78
63	4	0.942	29.73	29.73	9.53	8.04	29.54

PT NO	SC	TIP INLET STATIC PRESSURE PSIA	HUB INLET STATIC PRESSURE PSIA	1ST NOZ TIP EXIT STATIC PRESSURE PSIA	1ST NOZ HUB EXIT STATIC PRESSURE PSIA	1ST ROTOR TIP EXIT STATIC PRESSURE PSIA	1ST ROTOR HUB EXIT STATIC PRESSURE PSIA
34	4	22.93	22.62	18.08	16.27	12.65	15.21
130	1	21.18	21.17	17.09	15.27	12.51	14.81
132	1	21.99	21.83	17.59	15.88	12.33	14.70
132	2	21.86	21.55	17.65	16.00	12.31	14.62
132	3	21.86	21.55	17.65	16.00	12.31	14.62
133	1	20.83	20.61	16.62	14.91	11.86	14.14
133	2	20.71	20.42	16.64	14.91	11.82	14.03
133	3	20.59	20.50	16.53	15.29	11.96	14.28
133	4	20.98	20.94	16.79	15.07	12.00	14.14
134	1	21.38	21.28	17.81	15.76	12.41	14.46
134	2	21.86	21.80	17.82	15.68	12.31	14.62
134	3	21.93	21.96	18.19	16.35	12.59	14.93
134	4	22.31	21.83	18.24	16.43	12.80	14.91
135	1	20.48	20.47	16.57	14.91	11.96	14.07
135	2	19.87	19.76	16.27	14.81	11.94	14.12
135	3	20.47	20.41	16.61	15.37	12.29	14.32
135	4	20.68	20.66	17.05	15.41	12.41	14.52
136	1	21.75	21.70	18.22	16.59	13.12	15.27
136	2	21.67	21.67	17.84	16.23	12.90	15.01
136	3	21.24	21.31	17.71	16.19	12.77	15.15
136	4	20.88	20.83	17.60	16.11	12.77	14.81
137	1	20.83	20.71	18.16	17.08	14.28	16.06
137	2	21.31	21.23	18.33	17.10	14.28	16.06
137	3	21.14	21.00	18.06	16.92	14.12	16.06
138	1	20.20	20.11	17.51	16.39	13.59	15.41
138	2	20.00	19.98	17.60	16.39	13.49	15.56
138	3	20.63	20.55	18.13	16.51	13.53	15.41
138	4	20.30	20.27	17.83	16.78	13.93	15.82
61	1	29.30	29.27	23.73	21.51	17.57	20.37
61	2	29.29	29.14	23.47	21.20	17.45	20.23
61	3	28.60	28.47	23.30	20.67	17.14	19.96
61	4	28.91	28.81	23.26	20.86	17.28	20.00
62	1	28.63	28.44	23.24	20.70	17.04	19.84
62	2	28.18	28.10	22.88	20.72	16.90	19.64
62	3	28.16	28.08	22.86	20.55	16.98	19.70
62	4	28.43	28.42	23.18	20.88	17.06	19.80
63	1	28.34	28.33	23.25	20.80	16.90	19.76
63	2	28.60	28.62	23.41	21.02	17.10	20.11
63	3	28.78	28.54	23.47	21.16	16.80	19.84
63	4	28.56	28.49	23.35	20.98	16.96	19.78

PT NO	SC	2ND NOZ HUB EXIT STATIC PRESSURE PSIA	2ND ROTOR HUB EXIT STATIC PRESSURE PSIA	DOWN STREAM STATIC PRESSURE PSIA	DOWN STREAM TAYLOR STATIC PRESSURE PSIA	INLET CALORI-METER PRESSURE PSIA	INLET CALORI-METER TEMP DEG F
34	4	8.12	5.32	2.97	3.82	3.23	1187
130	1	7.13	4.39	1.64	3.04	2.05	1167
132	1	7.82	5.20	3.31	4.28	3.59	1195
132	2	7.82	5.26	1.99	4.56	3.88	1208
132	3	7.82	5.26	3.60	4.56	3.88	1208
133	1	7.60	5.42	4.32	4.97	4.57	1206
133	2	7.53	5.04	4.01	4.76	4.22	1199
133	3	7.58	5.06	3.83	4.80	4.04	1197
133	4	7.49	5.38	4.34	5.16	4.57	1199
134	1	7.53	5.48	4.26	5.13	4.41	1200
134	2	7.62	5.20	4.04	4.95	4.33	1202
134	3	7.78	5.40	3.73	4.66	3.96	1197
134	4	7.94	5.50	4.05	5.04	4.20	1199
135	1	7.43	6.05	5.50	6.53	5.63	1221
135	2	7.60	6.24	5.62	6.70	5.77	1221
135	3	7.76	6.56	5.82	6.86	5.95	1220
135	4	8.08	6.74	6.10	7.07	6.17	1221
136	1	8.21	6.56	5.81	6.83	5.89	1225
136	2	8.18	6.70	6.10	7.22	6.24	1230
136	3	8.27	6.26	5.66	6.35	5.89	1238
136	4	7.80	5.93	5.18	6.22	5.30	1236
137	1	10.72	9.89	9.47	10.42	9.59	1320
137	2	10.70	9.63	9.34	10.28	9.46	1316
137	3	10.32	9.59	9.24	10.15	9.34	1315
138	1	10.54	9.50	9.14	10.13	9.26	1315
138	2	10.56	9.40	9.03	10.17	9.12	1317
138	3	10.09	9.14	8.78	9.85	8.81	1311
138	4	10.68	9.65	9.26	10.07	9.42	1321
61	1	11.07	8.67	7.78	9.37	8.06	1286
61	2	11.13	9.14	8.24	9.75	8.51	1297
61	3	10.89	8.96	7.93	9.57	8.14	1291
61	4	11.19	9.34	8.44	10.03	8.75	1300
62	1	11.25	9.24	8.51	9.60	8.71	1304
62	2	11.11	8.73	7.87	9.60	8.16	1298
62	3	11.19	9.48	8.42	10.08	8.55	1305
62	4	11.49	9.55	8.65	10.02	8.90	1313
63	1	11.27	9.32	8.24	10.00	8.45	1307
63	2	11.82	9.67	8.81	10.23	9.10	1316
63	3	11.31	8.77	7.73	9.12	8.08	1309
63	4	11.17	8.75	7.87	9.52	8.12	1304

PT NO	SC	EXIT TEMP DEG F	1ST STAGE HUB REACTION	1ST STAGE TIP REACTION	2ND STAGE HUB REACTION	MAIN TORQUE READING IN-LB	SECONDARY TORQUE READING IN-LB
34	4	1162	0.146	0.553	0.352	476.5	32.7
130	1	1122	0.073	0.536	0.348	637.6	109.5
132	1	1165	0.171	0.566	0.345	474.1	52.5
132	2	1176	0.195	0.568	0.337	463.1	53.0
132	3	1176	0.195	0.568	0.337	463.1	53.0
133	1	1188	0.121	0.549	0.310	495.1	49.0
133	2	1179	0.140	0.561	0.340	529.1	47.2
133	3	1180	0.159	0.533	0.341	492.5	48.2
133	4	1191	0.142	0.551	0.300	471.6	49.7
134	1	1194	0.198	0.617	0.290	474.9	72.4
134	2	1184	0.155	0.594	0.325	502.7	69.5
134	3	1176	0.206	0.602	0.319	430.1	49.3
134	4	1183	0.218	0.593	0.324	438.5	43.2
135	1	1224	0.138	0.557	0.216	462.7	56.5
135	2	1230	0.119	0.544	0.212	451.0	50.0
135	3	1236	0.178	0.549	0.193	460.9	92.7
135	4	1242	0.152	0.582	0.213	469.5	99.0
136	1	1235	0.209	0.599	0.239	423.2	144.1
136	2	1246	0.190	0.576	0.222	472.7	143.8
136	3	1229	0.173	0.588	0.283	578.8	154.9
136	4	1217	0.205	0.575	0.261	508.6	121.5
137	1	1318	0.200	0.563	0.148	318.6	84.3
137	2	1316	0.200	0.578	0.186	320.4	91.8
137	3	1314	0.163	0.544	0.127	356.8	98.7
138	1	1315	0.212	0.606	0.198	179.5	67.9
138	2	1310	0.179	0.615	0.210	179.8	65.3
138	3	1305	0.228	0.678	0.176	187.6	66.1
138	4	1311	0.200	0.582	0.184	188.1	67.6
61	1	1280	0.131	0.533	0.252	698.6	54.7
61	2	1288	0.111	0.522	0.219	685.4	55.2
61	3	1286	0.084	0.541	0.214	664.1	54.8
61	4	1295	0.102	0.530	0.211	662.1	54.9
62	1	1293	0.103	0.548	0.229	597.7	47.8
62	2	1287	0.131	0.540	0.264	618.7	48.6
62	3	1296	0.101	0.525	0.201	570.8	48.0
62	4	1296	0.128	0.543	0.226	565.4	47.5
63	1	1293	0.124	0.557	0.226	542.4	38.1
63	2	1302	0.109	0.556	0.246	516.8	38.2
63	3	1279	0.154	0.574	0.279	563.7	42.7
63	4	1281	0.140	0.558	0.267	567.7	40.8

PT NO	SC	TARE TORQUE READING IN-LB	TOTAL TORQUE READING IN-LB	EMFM FLOW PPS	SPRAY FLOW PPS	TURBINE IDEAL DROP BTU/LB	TURBINE WORK BTU/LB
34	4	108.9	552.7	1.991	0.012	106.1	62.1
130	1	81.0	609.1	1.713	0.001	109.9	63.5
132	1	110.1	531.8	2.094	0.012	105.1	57.3
132	2	96.4	506.6	1.923	0.012	105.3	54.0
132	3	96.4	506.6	1.923	0.012	105.3	54.0
133	1	80.3	526.4	1.884	0.002	99.8	49.6
133	2	77.6	559.5	1.863	0.002	100.0	51.6
133	3	82.1	526.4	1.851	0.002	103.4	51.4
133	4	85.0	506.9	1.870	0.003	98.7	50.6
134	1	100.3	502.8	2.061	0.009	100.9	51.4
134	2	103.1	536.3	1.956	0.009	103.6	58.9
134	3	99.4	480.2	1.954	0.014	106.2	51.4
134	4	95.4	490.7	1.952	0.012	104.3	51.1
135	1	84.6	490.9	1.888	0.010	93.1	48.3
135	2	79.8	480.7	1.885	0.010	90.6	45.0
135	3	80.8	448.9	1.863	0.011	88.4	43.0
135	4	82.8	453.3	1.754	0.012	87.1	47.1
136	1	107.6	386.7	1.728	0.010	93.9	49.6
136	2	99.4	428.2	1.721	0.015	92.5	52.1
136	3	75.4	499.3	1.709	0.012	94.5	49.0
136	4	73.6	460.7	1.763	0.016	96.7	42.9
137	1	76.6	310.8	1.688	0.	64.6	31.3
137	2	81.8	310.4	1.696	0.013	65.9	33.0
137	3	69.1	327.1	1.678	0.002	67.7	30.2
138	1	99.2	210.8	1.612	0.005	62.0	27.3
138	2	103.8	218.3	1.611	0.008	63.7	29.3
138	3	114.3	235.8	1.612	0.007	65.8	33.9
138	4	109.2	229.7	1.613	0.011	64.1	31.9
61	1	75.1	719.0	2.413	0.	93.9	49.8
61	2	74.0	704.2	2.398	0.	92.7	48.4
61	3	77.4	686.8	2.390	0.	92.3	49.3
61	4	77.4	684.7	2.340	0.	90.3	50.2
62	1	91.1	641.0	2.333	0.	90.4	54.1
62	2	87.5	657.5	2.343	0.	92.7	53.7
62	3	71.0	593.7	2.354	0.	90.4	40.1
62	4	89.2	607.0	2.360	0.	90.3	49.9
63	1	98.9	603.2	2.387	0.	91.8	52.7
63	2	97.5	576.1	2.390	0.001	89.2	49.8
63	3	91.0	612.1	2.391	0.002	95.9	50.4
63	4	94.8	621.6	2.401	0.004	94.7	52.4

PT NC	SC	POWER OUTPUT HP	POWER OUTPUT KW	CORRECTED SPEED RPM	CORRECTED TURBINE WORK BTU/LB	CORRECTED POWER KW	CORRECTED POWER HP
34	4	174	130	20079	62.9	204	274
130	1	154	114	16020	64.2	177	238
132	1	169	126	20288	58.2	209	280
132	2	146	109	18409	54.8	178	239
132	3	146	109	18409	54.8	178	239
133	1	132	98	15979	50.6	171	229
133	2	136	101	15483	52.7	175	235
133	3	134	100	16284	52.4	172	231
133	4	133	99	16827	51.7	173	232
134	1	149	111	18957	52.3	186	249
134	2	163	121	19326	59.9	198	265
134	3	142	106	18817	52.3	173	232
134	4	141	105	18273	51.9	171	229
135	1	129	96	16760	49.4	170	228
135	2	119	89	15895	46.0	159	213
135	3	113	84	16065	43.9	148	198
135	4	116	87	16425	48.1	154	207
136	1	121	90	19950	50.5	150	201
136	2	126	94	18838	53.0	157	211
136	3	118	88	15078	49.8	147	198
136	4	106	79	14758	43.6	134	180
137	1	74	55	15291	31.9	96	129
137	2	79	59	16212	33.6	100	134
137	3	71	53	13952	30.8	91	122
138	1	62	46	18842	27.9	84	112
138	2	66	49	19457	29.9	88	118
138	3	77	57	20906	34.6	103	138
138	4	72	54	20191	32.6	95	128
61	1	169	126	14866	49.6	156	209
61	2	164	122	14678	48.2	152	204
61	3	166	124	15272	49.1	154	207
61	4	166	124	15290	50.1	156	209
62	1	178	133	17535	54.0	168	226
62	2	178	132	17040	53.6	168	225
62	3	133	99	14151	40.0	126	169
62	4	166	124	17263	49.7	156	209
63	1	178	132	18980	52.6	167	225
63	2	168	125	18392	49.6	158	212
63	3	170	127	17504	50.1	159	213
63	4	178	132	18028	52.3	168	225

PT NO	SC	CORRECTED FLOW PPS	1ST STAGE WORK BTU/LB	2ND STAGE WORK BTU/LB	1ST STAGE PERCENT WORK	2ND STAGE PERCENT WORK	TOTAL TO TOTAL EFFICIENCY
34	4	3.085	17.8	44.3	28.61	71.39	0.585
130	1	2.626	15.2	48.4	23.87	76.13	0.578
132	1	3.400	16.4	40.9	28.66	71.34	0.545
132	2	3.092	15.4	38.6	28.48	71.52	0.513
132	3	3.092	15.4	38.6	28.48	71.52	0.513
133	1	3.213	14.4	35.2	29.04	70.96	0.497
133	2	3.154	14.4	37.3	27.85	72.15	0.516
133	3	3.123	13.7	37.7	26.71	73.29	0.497
133	4	3.176	15.1	35.5	29.85	70.15	0.513
134	1	3.370	15.1	36.3	29.39	70.61	0.509
134	2	3.139	17.1	41.8	29.05	70.95	0.569
134	3	3.140	14.6	36.9	28.32	71.68	0.484
134	4	3.126	14.6	36.5	28.48	71.52	0.490
135	1	3.274	15.3	33.0	31.66	68.34	0.519
135	2	3.279	13.4	31.5	29.87	70.13	0.496
135	3	3.202	13.7	29.2	31.94	68.06	0.486
135	4	3.044	15.2	31.9	32.33	67.67	0.540
136	1	2.824	15.0	34.6	30.23	69.77	0.529
136	2	2.822	16.8	35.3	32.21	67.79	0.563
136	3	2.809	14.0	34.9	28.69	71.31	0.518
136	4	2.924	11.9	31.0	27.79	72.21	0.443
137	1	2.866	10.9	20.4	34.90	65.10	0.485
137	2	2.824	11.8	21.2	35.89	64.11	0.501
137	3	2.812	10.5	19.7	34.67	65.33	0.447
138	1	2.852	9.8	17.5	35.96	64.04	0.441
138	2	2.812	9.8	19.5	33.53	66.47	0.459
138	3	2.835	12.3	21.7	36.18	63.82	0.516
138	4	2.785	10.8	21.1	33.89	66.11	0.498
61	1	2.992	15.3	34.5	30.71	69.29	0.530
61	2	2.992	15.6	32.8	32.30	67.70	0.522
61	3	2.983	15.6	33.7	31.59	68.41	0.534
61	4	2.961	16.7	33.5	33.33	66.67	0.556
62	1	2.963	17.9	36.2	33.04	66.96	0.598
62	2	2.976	17.0	36.7	31.62	68.38	0.580
62	3	2.995	13.3	26.8	33.19	66.81	0.443
62	4	2.984	17.0	32.9	34.01	65.99	0.552
63	1	3.028	17.6	35.2	33.32	66.68	0.575
63	2	3.020	16.6	33.2	33.39	66.61	0.558
63	3	3.009	15.9	34.4	31.64	68.36	0.525
63	4	3.046	16.7	35.8	31.82	68.18	0.553

PT NO	SC	TOTAL TO STATIC EFFICIENCY	TURBINE VELOCITY RATIO	EXPANSION EXPONENT
34	4	0.521	0.3[illegible]	1.457
130	1	0.499	0.232	1.461
132	1	0.488	0.305	1.458
132	2	0.461	0.277	1.459
132	3	0.461	0.277	1.459
133	1	0.450	0.247	1.455
133	2	0.450	0.235	1.456
133	3	0.447	0.246	1.456
133	4	0.456	0.259	1.453
134	1	0.464	0.293	1.454
134	2	0.505	0.291	1.455
134	3	0.447	0.285	1.455
134	4	0.449	0.279	1.455
135	1	0.479	0.271	1.456
135	2	0.463	0.262	1.457
135	3	0.456	0.269	1.456
135	4	0.507	0.277	1.456
136	1	0.499	0.325	1.456
136	2	0.534	0.310	1.456
136	3	0.483	0.244	1.456
136	4	0.406	0.233	1.459
137	1	0.473	0.306	1.463
137	2	0.481	0.318	1.462
137	3	0.435	0.272	1.462
138	1	0.423	0.380	1.464
138	2	0.443	0.389	1.465
138	3	0.496	0.410	1.465
138	4	0.485	0.404	1.465
61	1	0.481	0.240	1.452
61	2	0.487	0.242	1.454
61	3	0.496	0.252	1.454
61	4	0.521	0.256	1.454
62	1	0.560	0.293	1.455
62	2	0.538	0.280	1.456
62	3	0.424	0.239	1.456
62	4	0.529	0.292	1.457
63	1	0.549	0.311	1.458
63	2	0.532	0.312	1.457
63	3	0.498	0.286	1.460
63	4	0.518	0.294	1.458

TABLE VI (Cont'd)

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

Test Date:	Oct. 8, 1964
Nominal Inlet Temperature, °F:	1550
Nominal Inlet Quality, Percent:	99
Total to Total Pressure Ratio:	2.968 to 3.817

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

DATE	PT NO	SC	TURBINE INLET TEMP DEG F	SPEED RPM	TOTAL TO TOTAL PRESSURE RATIO	TOTAL TO STATIC PRESSURE RATIO	SUPPLIED VAPOR QUALITY	INLET VAPOR QUALITY
1008.64	64	1	1537	19059	2.983	3.222	0.989	0.989
1008.64	64	2	1539	19480	3.120	3.345	0.988	0.988
1008.64	64	3	1539	19963	3.196	3.490	0.988	0.988
1008.64	64	4	1538	19477	3.151	3.470	0.988	0.988
1008.64	65	1	1541	20435	3.034	3.198	0.989	0.989
1008.64	65	2	1543	19749	2.968	3.156	0.989	0.989
1008.64	65	3	1543	19901	3.098	3.348	0.989	0.989
1008.64	65	4	1542	19078	3.159	3.356	0.989	0.989
1008.64	70	1	1536	14391	3.555	4.239	0.984	0.984
1008.64	70	2	1534	15106	3.479	4.136	0.984	0.984
1008.64	70	3	1532	15032	3.404	3.968	0.985	0.985
1008.64	70	4	1529	15450	3.486	4.164	0.986	0.986
1008.64	71	1	1529	16944	3.566	4.192	0.987	0.987
1008.64	71	2	1531	17198	3.544	4.165	0.987	0.987
1008.64	71	3	1530	16723	3.538	4.169	0.987	0.987
1008.64	71	4	1529	17258	3.624	4.146	0.987	0.987
1008.64	72	1	1530	16613	3.609	4.223	0.987	0.987
1008.64	72	2	1530	17544	3.628	4.151	0.986	0.986
1008.64	72	3	1535	17707	3.608	4.221	0.986	0.986
1008.64	72	4	1534	17982	3.639	4.263	0.986	0.986
1008.64	73	1	1540	19029	3.755	4.292	0.985	0.985
1008.64	73	2	1539	17519	3.693	4.265	0.985	0.985
1008.64	73	3	1539	18901	3.697	4.163	0.985	0.985
1008.64	73	4	1539	18196	3.665	4.141	0.986	0.986
1008.64	74	1	1539	19829	3.756	4.266	0.986	0.986
1008.64	74	2	1539	19197	3.790	4.273	0.985	0.985
1008.64	74	3	1539	19558	3.817	4.387	0.985	0.985
1008.64	74	4	1540	19630	3.775	4.488	0.985	0.985
1008.64	79	1	1527	15482	3.644	4.643	0.983	0.983
1008.64	79	2	1530	15883	3.539	4.457	0.983	0.983
1008.64	79	3	1531	14358	3.641	4.596	0.986	0.986
1008.64	79	4	1530	14874	3.657	4.548	0.985	0.985
1008.64	80	1	1527	16948	3.708	4.601	0.984	0.984
1008.64	80	2	1527	16592	3.708	4.462	0.984	0.984
1008.64	80	3	1528	17546	3.628	4.379	0.985	0.985
1008.64	80	4	1529	16934	3.753	4.465	0.985	0.985
1008.64	81	1	1531	17490	3.796	4.565	0.984	0.984
1008.64	81	2	1531	18379	3.770	4.454	0.984	0.984
1008.64	81	3	1531	17782	3.763	4.452	0.985	0.985
1008.64	81	4	1533	17984	3.788	4.508	0.985	0.985

PT NO	SC	EXIT VAPOR QUALITY	SUPPLY TOTAL PRESSURE PSIA	INLET TOTAL PRESSURE PSIA	EXIT TOTAL PRESSURE PSIA	DOWN STREAM TOTAL PRESSURE PSIA	SUPPLY STATIC PRESSURE PSIA
64	1	0.942	29.58	29.06	9.92	8.45	29.20
64	2	0.942	29.59	29.65	9.48	7.91	29.46
64	3	0.934	29.91	29.79	9.36	7.76	29.78
64	4	0.940	29.94	29.87	9.50	7.91	29.88
65	1	0.937	30.05	29.97	9.90	8.54	29.79
65	2	0.938	30.40	30.36	10.24	8.87	30.32
65	3	0.934	30.53	30.46	9.86	8.44	30.37
65	4	0.943	30.34	30.29	9.61	8.10	30.29
70	1	0.938	29.39	29.40	8.27	5.44	29.26
70	2	0.936	29.33	29.25	8.43	5.69	29.19
70	3	0.935	28.93	29.04	8.50	5.98	28.69
70	4	0.938	28.79	28.62	8.26	5.82	28.68
71	1	0.931	28.41	28.44	7.97	5.50	28.26
71	2	0.936	28.55	28.47	8.06	5.48	28.50
71	3	0.934	28.74	28.71	8.12	5.59	28.70
71	4	0.932	28.75	28.56	7.93	5.54	28.63
72	1	0.942	28.37	28.23	7.86	5.39	28.30
72	2	0.937	28.21	28.30	7.77	5.42	27.93
72	3	0.934	28.85	28.91	8.00	5.46	28.62
72	4	0.930	29.23	29.29	8.03	5.52	28.96
73	1	0.928	29.76	29.81	7.93	5.27	29.48
73	2	0.929	29.83	29.80	8.08	5.48	29.78
73	3	0.926	29.93	29.76	8.10	5.60	29.83
73	4	0.934	29.77	29.67	8.12	5.69	29.66
74	1	0.925	29.75	29.56	7.92	5.35	29.76
74	2	0.928	29.71	29.79	7.84	5.07	29.58
74	3	0.929	29.90	29.90	7.83	4.90	29.79
74	4	0.922	29.79	29.90	7.89	4.77	29.65
79	1	0.928	28.26	28.04	7.76	4.41	28.07
79	2	0.931	28.54	28.41	8.06	4.84	28.27
79	3	0.930	28.88	28.75	7.93	4.39	28.72
79	4	0.932	28.67	28.58	7.84	4.31	28.63
80	1	0.929	28.37	28.48	7.65	4.47	28.17
80	2	0.932	28.39	28.23	7.66	4.67	28.38
80	3	0.934	28.04	28.06	7.73	4.62	27.85
80	4	0.930	28.14	27.95	7.50	4.43	28.00
81	1	0.934	28.69	28.66	7.56	4.25	28.34
81	2	0.925	28.69	28.82	7.61	4.60	28.46
81	3	0.928	28.59	28.40	7.60	4.70	28.62
81	4	0.931	28.68	28.58	7.57	4.37	28.54

PT NC	SC	TIP INLET STATIC PRESSURE PSIA	HUB INLET STATIC PRESSURE PSIA	1ST NOZ TIP EXIT STATIC PRESSURE PSIA	1ST NOZ HUB EXIT STATIC PRESSURE PSIA	1ST ROTOR TIP EXIT STATIC PRESSURE PSIA	1ST ROTOR HUB EXIT STATIC PRESSURE PSIA
64	1	28.66	28.43	23.50	21.02	17.12	19.94
64	2	28.51	28.51	23.50	21.18	16.96	20.02
64	3	28.75	28.67	23.57	21.30	17.04	19.92
64	4	28.62	28.61	23.38	21.30	17.02	20.19
65	1	29.00	28.93	23.82	21.59	17.38	20.31
65	2	29.43	29.31	24.11	21.99	17.73	20.63
65	3	29.46	29.42	24.01	21.57	17.43	20.41
65	4	29.22	29.10	23.74	21.61	17.41	20.27
70	1	28.31	28.15	22.84	20.57	16.69	19.50
70	2	28.16	28.07	22.69	20.37	16.69	19.37
70	3	27.95	27.91	22.62	20.15	16.49	19.15
70	4	27.48	27.47	21.97	19.98	16.39	19.05
71	1	27.04	27.04	22.03	19.74	16.00	18.60
71	2	27.63	27.63	22.17	19.90	16.11	18.89
71	3	28.01	27.55	22.49	20.05	16.41	19.15
71	4	27.55	27.47	22.09	19.84	16.17	19.01
72	1	27.22	27.15	21.95	20.00	16.11	18.99
72	2	27.16	27.24	22.20	19.80	15.94	18.79
72	3	27.69	27.69	22.85	20.39	16.39	19.17
72	4	27.99	27.89	22.63	20.53	16.59	19.60
73	1	28.56	28.48	23.40	21.12	16.78	19.80
73	2	28.77	28.70	23.39	20.92	16.80	19.64
73	3	28.66	28.56	23.22	20.98	16.84	19.76
73	4	28.28	28.25	23.31	20.92	16.78	19.82
74	1	28.56	28.40	23.26	21.12	16.86	19.74
74	2	28.67	28.62	23.33	21.10	16.82	19.80
74	3	28.64	28.54	23.37	20.94	16.86	19.94
74	4	28.70	28.76	23.45	21.02	16.61	19.76
79	1	27.09	27.01	21.64	19.58	16.00	18.81
79	2	27.23	27.16	21.99	19.60	16.06	18.58
79	3	27.99	27.88	22.28	20.05	16.23	19.05
79	4	27.44	27.41	22.08	20.19	16.31	19.11
80	1	27.19	27.15	21.98	19.80	16.11	18.81
80	2	27.32	27.18	21.96	19.70	16.06	18.70
80	3	26.88	26.81	21.84	19.56	15.78	18.71
80	4	27.28	27.12	22.00	19.84	15.94	18.68
81	1	27.69	27.66	22.46	20.29	16.25	18.95
81	2	27.57	27.56	22.55	20.07	16.25	19.21
81	3	27.60	27.51	22.46	20.09	16.23	18.99
81	4	27.52	27.53	22.28	19.98	16.13	19.05

PT NC	SC	2ND NOZ HUB EXIT STATIC PRESSURE PSIA	2ND ROTOR HUB EXIT STATIC PRESSURE PSIA	DOWN STREAM STATIC PRESSURE PSIA	DOWN STREAM TAYLOR STATIC PRESSURE PSIA	INLET CALORI-METER PRESSURE PSIA	INLET CALORI-METER TEMP DEG F
64	1	11.29	9.18	8.29	9.53	8.59	1307
64	2	11.45	8.85	7.78	9.01	8.02	1295
64	3	11.13	8.57	7.57	9.00	7.82	1292
64	4	11.37	8.63	7.71	9.31	8.02	1295
65	1	11.62	9.40	8.36	10.02	8.67	1310
65	2	11.90	9.63	8.71	10.07	9.02	1315
65	3	11.54	9.12	8.25	9.74	8.55	1311
65	4	11.39	9.04	7.91	9.46	8.27	1303
70	1	10.15	6.93	5.28	6.67	5.59	1238
70	2	10.11	7.09	5.58	7.00	5.81	1243
70	3	10.05	7.29	5.86	7.15	6.09	1250
70	4	9.91	6.91	5.68	7.02	5.93	1252
71	1	9.83	6.78	5.41	6.78	5.65	1249
71	2	9.91	6.86	5.36	6.77	5.69	1250
71	3	9.99	6.89	5.43	6.82	5.69	1251
71	4	9.89	6.93	5.45	6.81	5.69	1251
72	1	10.05	6.72	5.34	6.66	5.65	1249
72	2	9.95	6.80	5.26	6.66	5.56	1244
72	3	10.18	6.84	5.29	6.86	5.61	1245
72	4	10.40	6.86	5.37	6.77	5.71	1247
73	1	10.50	6.93	5.11	6.70	5.44	1241
73	2	10.30	6.99	5.37	6.85	5.65	1245
73	3	10.46	7.19	5.42	7.16	5.79	1248
73	4	10.48	7.19	5.61	7.27	5.89	1252
74	1	10.42	6.97	5.22	6.76	5.56	1245
74	2	10.38	6.95	4.91	6.52	5.22	1237
74	3	10.44	6.82	4.72	6.28	5.06	1232
74	4	10.48	6.64	4.61	6.21	4.89	1228
79	1	9.79	6.09	4.24	5.54	4.57	1212
79	2	9.83	6.40	4.69	5.76	5.00	1220
79	3	9.85	6.28	4.23	5.29	4.57	1223
79	4	9.89	6.30	4.15	5.37	4.41	1216
80	1	9.79	6.17	4.33	5.50	4.61	1217
80	2	9.75	6.36	4.50	5.69	4.83	1222
80	3	9.81	6.40	4.50	5.54	4.79	1225
80	4	9.85	6.30	4.25	5.43	4.55	1218
81	1	9.95	6.28	4.05	5.48	4.39	1212
81	2	9.95	6.44	4.45	5.72	4.71	1219
81	3	9.99	6.42	4.58	5.77	4.87	1224
81	4	9.93	6.36	4.27	5.52	4.57	1220

PT NO	SC	EXIT TEMP DEG F	1ST STAGE HUB REACTION	1ST STAGE TIP REACTION	2ND STAGE HUB REACTION	MAIN TORQUE READING IN-LB	SECONDARY TORQUE READING IN-LB
64	1	1293	0.130	0.568	0.238	508.5	37.7
64	2	1278	0.140	0.574	0.284	494.6	40.0
64	3	1274	0.160	0.565	0.276	547.1	38.4
64	4	1280	0.131	0.551	0.288	512.4	37.9
65	1	1294	0.152	0.564	0.249	509.1	38.7
65	2	1297	0.160	0.559	0.250	526.2	39.9
65	3	1292	0.133	0.560	0.262	564.6	37.7
65	4	1284	0.154	0.546	0.256	516.4	39.0
70	1	1216	0.126	0.543	0.323	743.6	71.6
70	2	1227	0.118	0.533	0.309	714.5	69.7
70	3	1232	0.120	0.550	0.293	710.7	72.1
70	4	1230	0.111	0.508	0.310	670.8	72.3
71	1	1223	0.136	0.546	0.323	681.3	66.7
71	2	1223	0.122	0.546	0.322	613.6	65.3
71	3	1222	0.110	0.550	0.319	667.9	67.5
71	4	1223	0.100	0.530	0.311	662.5	66.1
72	1	1224	0.125	0.534	0.342	605.4	59.1
72	2	1220	0.124	0.569	0.334	614.0	58.8
72	3	1228	0.147	0.576	0.342	621.6	54.7
72	4	1226	0.112	0.536	0.350	649.1	61.9
73	1	1217	0.154	0.568	0.351	619.9	52.4
73	2	1217	0.147	0.565	0.333	661.3	51.0
73	3	1226	0.140	0.546	0.329	628.1	50.3
73	4	1230	0.129	0.561	0.328	598.4	48.0
74	1	1220	0.160	0.554	0.343	615.1	46.3
74	2	1212	0.152	0.563	0.343	613.9	50.8
74	3	1210	0.118	0.558	0.352	587.6	51.2
74	4	1204	0.146	0.578	0.372	636.2	48.7
79	1	1192	0.095	0.519	0.367	721.9	22.4
79	2	1211	0.121	0.534	0.348	611.0	22.7
79	3	1190	0.120	0.537	0.355	738.3	24.6
79	4	1194	0.132	0.525	0.355	685.9	21.9
80	1	1194	0.120	0.537	0.363	688.4	62.2
80	2	1200	0.121	0.537	0.348	697.9	89.3
80	3	1198	0.106	0.553	0.349	640.1	91.0
80	4	1199	0.143	0.555	0.364	714.1	95.4
81	1	1190	0.160	0.557	0.369	642.5	110.0
81	2	1200	0.107	0.564	0.352	684.0	99.3
81	3	1200	0.134	0.562	0.361	684.2	95.2
81	4	1200	0.112	0.549	0.359	652.5	97.0

PT NC	SC	TARE TORQUE READING IN-LB	TOTAL TORQUE READING IN-LB	EMFM FLOW PPS	SPRAY FLOW PPS	TURBINE IDEAL DROP BTU/LB	TURBINE WORK BTU/LB
64	1	102.2	573.0	2.408	0.002	91.2	50.8
64	2	105.4	560.0	2.411	0.004	94.6	50.7
64	3	108.9	617.7	2.403	0.003	96.4	57.5
64	4	105.3	579.9	2.406	0.003	95.4	52.6
65	1	112.4	582.8	2.422	0.004	92.6	55.1
65	2	107.3	593.7	2.423	0.004	91.0	54.3
65	3	108.5	635.4	2.433	0.004	94.4	58.3
65	4	102.4	579.9	2.444	0.004	95.7	50.8
70	1	72.3	744.2	2.289	0.	103.9	52.5
70	2	76.3	721.1	2.277	0.	102.3	53.6
70	3	75.9	714.5	2.173	0.	100.6	55.4
70	4	78.2	676.7	2.167	0.	102.5	54.1
71	1	86.7	701.4	2.188	0.	104.2	60.9
71	2	88.5	636.7	2.185	0.	103.7	56.2
71	3	85.4	685.9	2.203	0.001	103.7	58.4
71	4	88.9	685.3	2.207	0.	105.5	60.1
72	1	84.8	631.1	2.293	0.002	105.0	51.3
72	2	91.0	646.3	2.287	0.	105.3	55.6
72	3	92.2	659.1	2.270	0.002	105.0	57.7
72	4	94.3	681.5	2.273	0.001	105.7	60.5
73	1	102.0	669.5	2.269	0.002	108.1	63.0
73	2	90.8	701.1	2.252	0.002	106.9	61.2
73	3	101.1	678.9	2.264	0.003	107.0	63.6
73	4	95.9	646.3	2.275	0.004	106.4	58.0
74	1	107.9	676.8	2.289	0.005	108.2	65.7
74	2	103.3	666.4	2.281	0.004	108.8	62.9
74	3	105.9	642.3	2.283	0.005	109.3	61.7
74	4	106.5	693.9	2.277	0.005	108.5	67.1
79	1	78.4	778.0	2.227	0.	105.3	60.7
79	2	80.7	669.1	2.085	0.	103.2	57.2
79	3	72.1	785.7	2.091	0.	105.7	60.5
79	4	75.0	738.9	2.104	0.	105.9	58.6
80	1	86.7	712.9	2.217	0.	106.7	61.1
80	2	84.7	693.3	2.209	0.	106.8	58.4
80	3	91.0	640.2	2.203	0.	105.2	57.2
80	4	86.6	705.4	2.207	0.	107.6	60.7
81	1	90.6	623.2	2.168	0.	108.5	56.4
81	2	97.2	681.9	2.180	0.001	108.0	64.5
81	3	92.8	681.8	2.199	0.002	107.9	61.8
81	4	94.3	649.7	2.198	0.003	108.5	59.6

PT NO	SC	POWER OUTPUT HP	POWER OUTPUT KW	CORRECTED SPEED RPM	CORRECTED TURBINE WORK BTU/LB	CORRECTED POWER KW	CORRECTED POWER HP
64	1	173	129	19031	50.7	163	219
64	2	173	129	19446	50.6	161	217
64	3	195	145	19929	57.3	182	245
64	4	179	133	19446	52.5	168	225
65	1	188	140	20389	54.9	174	234
65	2	186	138	19698	54.0	170	228
65	3	200	149	19849	58.0	184	247
65	4	175	130	19035	50.5	162	217
70	1	169	126	14382	52.4	161	216
70	2	172	128	15100	53.6	165	222
70	3	170	127	15029	55.4	164	220
70	4	165	123	15454	54.1	162	218
71	1	188	140	16944	60.9	184	247
71	2	173	129	17193	56.2	168	226
71	3	182	135	16720	58.4	177	237
71	4	187	139	17258	60.1	183	246
72	1	166	124	16612	51.3	162	217
72	2	179	134	17544	55.6	175	235
72	3	185	138	17694	57.6	177	237
72	4	194	145	17972	60.4	186	250
73	1	202	150	19001	62.8	188	253
73	2	194	145	17496	61.0	182	244
73	3	203	151	18877	63.4	190	255
73	4	186	139	18169	57.8	174	234
74	1	212	158	19802	65.5	199	267
74	2	202	151	19172	62.7	190	255
74	3	199	148	19533	61.5	186	250
74	4	216	161	19603	66.9	201	270
79	1	191	142	15498	60.8	189	254
79	2	168	125	15892	57.2	164	221
79	3	179	133	14356	60.5	173	232
79	4	174	130	14876	58.6	170	227
80	1	191	143	16962	61.2	190	255
80	2	182	136	16605	58.5	180	242
80	3	178	132	17555	57.2	175	235
80	4	189	141	16941	60.7	186	249
81	1	172	129	17492	56.4	168	225
81	2	198	148	18382	64.5	193	259
81	3	192	143	17783	61.8	186	250
81	4	185	138	17979	59.6	178	239

PT NO	SC	CORRECTED FLOW PPS	1ST STAGE WORK BTU/LB	2ND STAGE WORK BTU/LB	1ST STAGE PERCENT WORK	2ND STAGE PERCENT WORK	TOTAL TO TOTAL EFFICIENCY
64	1	3.060	16.4	34.4	32.29	67.71	0.558
64	2	3.033	15.8	35.0	31.07	68.93	0.537
64	3	3.021	18.0	39.6	31.22	68.78	0.597
64	4	3.037	15.8	36.9	29.98	70.02	0.552
65	1	3.019	17.9	37.3	32.42	67.58	0.595
65	2	2.993	17.7	36.6	32.56	67.44	0.596
65	3	3.012	18.8	39.4	32.32	67.68	0.618
65	4	3.041	16.1	34.6	31.75	68.25	0.530
70	1	2.921	14.2	38.2	27.12	72.88	0.505
70	2	2.928	15.0	38.6	27.97	72.03	0.524
70	3	2.815	16.1	39.3	29.09	70.91	0.551
70	4	2.851	14.9	39.2	27.52	72.48	0.528
71	1	2.872	17.2	43.7	28.18	71.82	0.585
71	2	2.845	15.9	40.3	28.32	71.68	0.542
71	3	2.876	16.0	42.4	27.33	72.67	0.563
71	4	2.897	16.7	43.4	27.80	72.20	0.570
72	1	3.003	13.6	37.7	26.43	73.57	0.488
72	2	2.993	15.4	40.2	27.69	72.31	0.528
72	3	2.913	15.8	41.9	27.32	72.68	0.549
72	4	2.926	15.8	44.6	26.18	73.82	0.572
73	1	2.849	16.9	46.1	26.82	73.18	0.582
73	2	2.835	17.1	44.1	27.97	72.03	0.572
73	3	2.853	17.7	45.9	27.81	72.19	0.594
73	4	2.862	15.6	42.4	26.85	73.15	0.545
74	1	2.887	17.8	48.0	27.05	72.95	0.608
74	2	2.876	17.1	45.8	27.14	72.86	0.578
74	3	2.877	16.1	45.6	26.08	73.92	0.564
74	4	2.861	18.0	49.1	26.87	73.13	0.618
79	1	2.959	15.4	45.2	25.44	74.56	0.576
79	2	2.732	15.7	41.5	27.40	72.60	0.554
79	3	2.721	16.2	44.3	26.76	73.24	0.573
79	4	2.749	15.0	43.6	25.64	74.36	0.553
80	1	2.945	15.8	45.3	25.89	74.11	0.573
80	2	2.927	15.7	42.7	26.83	73.17	0.547
80	3	2.913	14.9	42.2	26.13	73.87	0.544
80	4	2.904	16.2	44.5	26.67	73.33	0.564
81	1	2.824	14.9	41.4	26.52	73.48	0.519
81	2	2.844	16.8	47.7	26.00	74.00	0.597
81	3	2.865	16.4	45.4	26.59	73.41	0.573
81	4	2.841	15.6	44.0	26.19	73.81	0.550

PT NO	SC	TOTAL TO STATIC EFFICIENCY	TURBINE VELOCITY RATIO	EXPANSION EXPONENT
64	1	0.524	0.317	1.457
64	2	0.509	0.320	1.456
64	3	0.559	0.323	1.456
64	4	0.513	0.315	1.456
65	1	0.571	0.341	1.457
65	2	0.567	0.331	1.457
65	3	0.582	0.326	1.458
65	4	0.506	0.312	1.457
70	1	0.450	0.219	1.452
70	2	0.467	0.231	1.452
70	3	0.495	0.233	1.453
70	4	0.469	0.236	1.454
71	1	0.525	0.258	1.455
71	2	0.486	0.262	1.455
71	3	0.505	0.255	1.455
71	4	0.521	0.264	1.455
72	1	0.440	0.252	1.455
72	2	0.483	0.268	1.454
72	3	0.495	0.269	1.454
72	4	0.516	0.272	1.454
73	1	0.534	0.288	1.453
73	2	0.521	0.265	1.453
73	3	0.550	0.288	1.453
73	4	0.503	0.278	1.454
74	1	0.560	0.300	1.454
74	2	0.535	0.290	1.453
74	3	0.517	0.294	1.453
74	4	0.555	0.293	1.453
79	1	0.494	0.229	1.451
79	2	0.477	0.238	1.450
79	3	0.494	0.213	1.454
79	4	0.482	0.221	1.453
80	1	0.500	0.251	1.452
80	2	0.486	0.248	1.452
80	3	0.481	0.264	1.454
80	4	0.505	0.253	1.453
81	1	0.463	0.260	1.452
81	2	0.537	0.275	1.452
81	3	0.515	0.266	1.453
81	4	0.493	0.268	1.453

TABLE VI (Cont'd)

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

Test Date:	Oct. 8, 1964
Nominal Inlet Temperature, °F:	1550
Nominal Inlet Quality, Percent:	99
Total to Total Pressure Ratio:	3.651 to 4.004

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

DATE	PT NO	SC	TURBINE INLET TEMP DEG F	SPEED RPM	TOTAL TO TOTAL PRESSURE RATIO	TOTAL TO STATIC PRESSURE RATIO	SUPPLIED VAPOR QUALITY	INLET VAPOR QUALITY
1008.64	82	1	1531	17751	3.817	4.474	0.983	0.983
1008.64	82	2	1531	18863	3.788	4.391	0.984	0.984
1008.64	82	3	1530	19597	3.868	4.721	0.985	0.985
1008.64	82	4	1529	17800	3.840	4.530	0.984	0.984
1008.64	83	1	1534	17324	3.757	4.310	0.984	0.984
1008.64	83	2	1535	16820	3.770	4.646	0.985	0.985
1008.64	83	3	1536	19614	4.004	4.638	0.984	0.984
1008.64	83	4	1537	19490	3.939	4.532	0.983	0.983
1008.64	88	1	1529	14820	3.651	4.707	0.987	0.987
1008.64	88	2	1528	15726	3.735	4.591	0.986	0.986
1008.64	88	3	1528	15567	3.683	4.497	0.985	0.985
1008.64	88	4	1529	15261	3.738	4.532	0.988	0.988
1008.64	89	1	1527	17123	3.856	4.652	0.983	0.983
1008.64	89	2	1528	17303	3.817	4.620	0.983	0.983
1008.64	89	3	1527	17495	3.840	4.645	0.983	0.983
1008.64	90	1	1530	18164	3.855	4.546	0.983	0.983
1008.64	90	2	1533	18853	3.842	4.724	0.984	0.984
1008.64	90	3	1529	18036	3.880	4.781	0.983	0.983
1008.64	90	4	1529	19270	3.856	4.688	0.982	0.982
1008.64	91	1	1527	19094	3.929	4.699	0.983	0.983
1008.64	91	2	1526	19105	3.946	4.716	0.982	0.982
1008.64	91	3	1527	19509	3.939	4.609	0.983	0.983
1008.64	91	4	1529	18239	3.974	4.709	0.982	0.982
1008.64	92	1	1530	19088	3.945	4.561	0.982	0.982
1008.64	92	2	1529	21159	3.968	4.594	0.982	0.982
1008.64	92	3	1529	18771	3.959	4.657	0.982	0.982
1008.64	92	4	1527	20168	3.975	4.691	0.981	0.981
1008.64	97	1	1520	15372	3.807	4.889	0.981	0.981
1008.64	98	1	1540	17761	3.961	4.812	0.981	0.981
1008.64	98	2	1539	17437	3.908	4.773	0.980	0.980
1008.64	98	3	1538	17725	3.876	4.766	0.981	0.981
1008.64	125	1	1564	19383	3.982	4.790	0.975	0.975
1008.64	125	2	1568	18677	3.998	4.725	0.976	0.976
1008.64	99	1	1529	18170	3.921	4.798	0.981	0.981
1008.64	99	2	1522	17261	3.906	4.771	0.981	0.981
1008.64	100	1	1539	17913	3.923	4.852	0.981	0.981
1008.64	100	2	1533	18995	3.954	4.763	0.981	0.981
1008.64	100	3	1526	19250	3.990	4.819	0.981	0.981
1008.64	100	4	1543	18544	4.000	4.777	0.980	0.980
1008.64	101	1	1532	19630	3.975	4.732	0.981	0.981

PT NO	SC	EXIT VAPOR QUALITY	SUPPLY TOTAL PRESSURE PSIA	INLET TOTAL PRESSURE PSIA	EXIT TOTAL PRESSURE PSIA	DOWN STREAM TOTAL PRESSURE PSIA	SUPPLY STATIC PRESSURE PSIA
82	1	0.934	29.00	29.10	7.60	4.50	28.76
82	2	0.931	28.81	28.64	7.60	4.81	28.65
82	3	0.923	28.55	28.21	7.38	4.06	28.58
82	4	0.938	28.29	28.27	7.37	3.97	28.21
83	1	0.940	28.87	28.20	7.68	4.39	28.65
83	2	0.940	29.29	29.17	7.77	4.09	29.20
83	3	0.930	29.42	28.91	7.35	3.76	29.22
83	4	0.930	29.46	29.23	7.48	3.91	29.44
88	1	0.936	28.19	28.20	7.72	3.72	27.91
88	2	0.931	28.40	28.37	7.60	3.93	28.17
88	3	0.933	28.35	28.36	7.70	4.09	27.96
88	4	0.933	28.30	28.14	7.57	3.61	28.18
89	1	0.930	28.41	28.20	7.37	3.76	28.32
89	2	0.933	28.13	28.01	7.37	3.74	28.11
89	3	0.928	28.09	28.10	7.32	3.82	27.97
90	1	0.932	28.66	28.64	7.43	3.87	28.51
90	2	0.928	28.66	28.47	7.46	3.67	28.49
90	3	0.926	28.54	28.37	7.35	3.31	28.32
90	4	0.919	28.54	28.39	7.40	3.62	28.45
91	1	0.931	28.05	28.01	7.14	3.45	27.90
91	2	0.932	28.06	27.85	7.11	3.30	27.92
91	3	0.931	28.14	28.23	7.14	3.34	27.94
91	4	0.936	28.57	28.33	7.19	3.26	28.54
92	1	0.933	28.57	28.42	7.24	3.36	28.40
92	2	0.929	28.51	28.67	7.18	3.31	28.32
92	3	0.931	28.62	28.34	7.23	3.34	28.56
92	4	0.930	28.56	28.39	7.18	3.29	28.56
97	1	0.935	28.03	27.95	7.36	3.09	27.94
98	1	0.923	30.15	30.11	7.61	3.03	29.91
98	2	0.927	29.90	29.98	7.65	2.93	29.77
98	3	0.926	29.58	29.78	7.63	2.81	29.39
125	1	0.929	33.50	33.23	8.41	2.74	33.32
125	2	0.922	33.60	33.23	8.41	2.83	33.50
99	1	0.927	29.02	29.09	7.40	2.95	28.85
99	2	0.936	27.72	27.68	7.10	3.10	27.65
100	1	0.925	30.30	29.90	7.72	3.07	30.08
100	2	0.925	29.18	29.00	7.38	2.85	29.20
100	3	0.925	28.48	28.26	7.14	2.77	28.51
100	4	0.926	30.68	30.76	7.67	3.11	30.46
101	1	0.924	29.37	29.39	7.39	3.01	29.22

PT NO	SC	TIP INLET STATIC PRESSURE PSIA	HUB INLET STATIC PRESSURE PSIA	1ST NOZ TIP EXIT STATIC PRESSURE PSIA	1ST NOZ HUB EXIT STATIC PRESSURE PSIA	1ST ROTOR TIP EXIT STATIC PRESSURE PSIA	1ST RCTOR HUB EXIT STATIC PRESSURE PSIA
82	1	27.98	27.97	22.62	20.49	16.41	19.35
82	2	27.81	27.64	22.52	20.03	16.09	18.91
82	3	27.52	27.19	22.22	20.27	15.74	18.52
82	4	27.59	27.38	22.27	20.05	15.96	18.73
83	1	28.22	27.84	23.41	21.91	16.74	19.54
83	2	27.82	27.87	23.15	20.49	16.41	19.15
83	3	28.31	28.14	23.19	20.88	16.53	19.44
83	4	28.36	28.12	23.05	20.78	16.65	19.42
88	1	27.02	27.08	21.90	19.94	15.90	18.79
88	2	27.10	27.03	21.89	19.68	16.21	18.93
88	3	27.05	26.99	21.88	19.76	16.06	18.75
88	4	27.16	27.05	21.86	19.64	15.98	18.60
89	1	27.18	27.04	22.17	20.41	16.23	18.99
89	2	26.76	26.61	21.69	19.96	16.02	18.79
89	3	27.34	27.38	21.96	19.72	15.96	18.75
90	1	27.53	27.53	22.36	20.45	16.25	19.01
90	2	27.74	27.42	22.46	20.33	16.31	18.97
90	3	27.40	27.16	22.15	20.13	16.23	18.99
90	4	27.13	27.07	22.13	19.96	16.09	19.05
91	1	26.87	26.77	22.27	20.03	16.06	18.71
91	2	27.19	26.82	22.12	19.98	16.00	18.71
91	3	27.16	27.13	22.23	20.31	16.00	18.81
91	4	27.75	27.22	22.65	20.43	15.98	18.75
92	1	27.26	27.16	22.61	20.68	15.94	18.95
92	2	27.51	27.49	22.52	20.13	15.78	18.77
92	3	27.64	27.14	22.34	20.55	16.31	19.01
92	4	27.34	27.29	22.48	20.07	16.15	18.93
97	1	26.76	26.68	21.60	19.52	15.90	18.70
98	1	29.02	29.02	23.71	21.43	17.24	20.17
98	2	28.73	28.70	23.49	21.24	16.98	20.03
98	3	28.50	28.51	23.27	21.08	16.94	19.90
125	1	31.99	31.98	26.70	24.17	19.15	22.36
125	2	32.70	32.64	27.10	26.02	19.38	22.85
99	1	27.96	27.84	22.67	20.45	16.59	19.50
99	2	26.55	26.43	21.67	19.60	15.82	18.62
100	1	28.78	28.71	23.83	21.16	16.61	19.76
100	2	28.10	27.86	22.91	20.90	16.74	19.56
100	3	27.19	27.10	22.19	20.02	16.04	18.89
100	4	29.54	29.52	24.08	21.69	17.45	20.43
101	1	28.09	28.09	22.95	20.72	16.71	19.56

PT NO	SC	2ND NOZ HUB EXIT STATIC PRESSURE PSIA	2ND ROTOR HUB EXIT STATIC PRESSURE PSIA	DOWN STREAM STATIC PRESSURE PSIA	DOWN STREAM TAYLOR STATIC PRESSURE PSIA	INLET CALORI- METER PRESSURE PSIA	INLET CALORI- METER TEMP DEG F
82	1	10.20	6.48	4.33	5.77	4.63	1215
82	2	9.97	6.56	4.68	5.88	4.96	1225
82	3	9.83	6.05	3.93	5.09	4.22	1212
82	4	9.93	6.24	3.78	5.26	4.08	1202
83	1	10.40	6.70	4.24	5.78	4.57	1215
83	2	10.01	6.30	3.96	5.25	4.33	1214
83	3	10.28	6.34	3.57	4.98	3.92	1201
83	4	10.28	6.50	3.73	5.11	4.02	1201
88	1	9.79	5.99	3.50	4.69	3.78	1209
88	2	9.77	6.19	3.80	4.91	4.04	1209
88	3	9.73	6.30	3.92	4.86	4.33	1213
88	4	9.57	6.24	3.41	4.51	3.72	1210
89	1	9.95	6.11	3.52	4.68	3.88	1196
89	2	9.83	6.09	3.53	4.58	3.88	1195
89	3	9.73	6.05	3.69	4.70	4.00	1199
90	1	9.99	6.30	3.69	4.96	4.00	1198
90	2	9.95	6.07	3.49	4.61	3.88	1198
90	3	9.87	5.97	3.09	4.42	3.49	1185
90	4	10.11	6.09	3.41	5.00	3.78	1188
91	1	9.75	5.97	3.27	4.69	3.62	1189
91	2	9.79	5.95	3.09	4.71	3.53	1183
91	3	9.95	6.11	3.13	4.64	3.43	1182
91	4	10.01	6.07	3.11	4.57	3.47	1181
92	1	10.13	6.26	3.08	4.60	3.43	1180
92	2	10.03	6.21	3.07	4.19	3.45	1179
92	3	10.11	6.15	3.06	4.47	3.43	1180
92	4	9.91	6.09	3.12	4.63	3.51	1179
97	1	9.30	5.73	2.89	3.95	3.23	1167
98	1	10.26	6.26	2.77	3.84	3.21	1171
98	2	10.34	6.26	2.64	3.72	3.11	1167
98	3	10.18	6.21	2.63	3.70	3.03	1165
125	1	11.39	6.99	2.43	3.99	3.17	1153
125	2	11.66	7.11	2.48	3.71	3.17	1155
99	1	9.89	6.05	2.68	3.72	3.11	1167
99	2	9.50	5.81	2.91	4.30	3.23	1167
100	1	10.18	6.24	2.91	4.09	3.29	1174
100	2	10.09	6.13	2.61	3.88	3.07	1168
100	3	9.77	5.91	2.44	3.80	2.92	1161
100	4	10.54	6.42	2.89	4.17	3.35	1174
101	1	10.15	6.21	2.71	4.14	3.15	1167

PT NC	SC	EXIT TEMP DEG F	1ST STAGE HUB REACTION	1ST STAGE TIP REACTION	2ND STAGE HUB REACTION	MAIN TORQUE READING IN-LB	SECONDARY TORQUE READING IN-LB
82	1	1199	0.138	0.551	0.370	651.8	94.8
82	2	1198	0.133	0.565	0.351	638.6	95.8
82	3	1189	0.203	0.567	0.381	712.0	107.8
82	4	1188	0.160	0.570	0.377	618.4	97.9
83	1	1203	0.286	0.604	0.368	611.6	93.6
83	2	1203	0.154	0.582	0.363	646.0	96.9
83	3	1183	0.167	0.575	0.384	624.1	95.3
83	4	1195	0.158	0.558	0.372	625.4	94.6
88	1	1180	0.141	0.547	0.375	695.4	6.3
88	2	1176	0.093	0.523	0.357	685.9	6.5
88	3	1197	0.122	0.532	0.348	669.1	6.3
88	4	1175	0.126	0.536	0.343	698.6	5.6
89	1	1181	0.174	0.545	0.379	708.4	96.3
89	2	1182	0.145	0.527	0.372	672.7	100.5
89	3	1179	0.120	0.552	0.375	720.2	103.1
90	1	1190	0.173	0.551	0.370	648.3	103.7
90	2	1180	0.163	0.555	0.382	670.1	103.6
90	3	1173	0.139	0.539	0.381	718.3	104.3
90	4	1177	0.111	0.544	0.390	717.1	102.3
91	1	1181	0.164	0.575	0.380	627.1	101.5
91	2	1174	0.156	0.565	0.385	603.4	97.2
91	3	1184	0.185	0.571	0.387	597.9	97.0
91	4	1180	0.197	0.588	0.392	605.1	99.5
92	1	1178	0.207	0.587	0.384	601.8	96.7
92	2	1209	0.162	0.589	0.388	550.8	95.8
92	3	1176	0.185	0.547	0.389	625.5	96.5
92	4	1173	0.138	0.568	0.381	579.9	101.6
97	1	1157	0.104	0.529	0.356	691.0	6.4
98	1	1181	0.147	0.558	0.374	727.1	101.2
98	2	1181	0.141	0.562	0.381	728.1	100.9
98	3	1178	0.141	0.558	0.376	729.3	99.7
125	1	1222	0.187	0.583	0.370	664.9	125.3
125	2	1194	0.330	0.598	0.380	768.7	116.1
99	1	1166	0.116	0.547	0.371	649.7	7.6
99	2	1166	0.126	0.549	0.371	652.3	76.0
100	1	1178	0.155	0.588	0.370	692.0	69.5
100	2	1175	0.161	0.553	0.379	636.5	53.2
100	3	1168	0.136	0.554	0.381	634.2	58.5
100	4	1192	0.143	0.559	0.380	601.0	24.0
101	1	1172	0.138	0.551	0.379	695.3	113.2

PT NO	SC	TARE TORQUE READING IN-LB	TOTAL TORQUE READING IN-LB	EMFM FLOW PPS	SPRAY FLOW PPS	TURBINE IDEAL DROP BTU/LB	TURBINE. WORK BTU/LB
82	1	92.6	649.6	2.315	0.003	108.9	55.8
82	2	100.8	643.6	2.316	0.003	108.4	58.8
82	3	106.2	710.4	2.321	0.003	110.0	67.3
82	4	92.9	613.4	2.320	0.004	109.2	52.8
83	1	89.4	607.4	2.319	0.003	107.8	50.9
83	2	86.0	635.1	2.316	0.005	108.2	51.7
83	3	106.4	635.2	2.308	0.006	112.5	60.5
83	4	105.4	636.2	2.315	0.004	111.3	60.1
88	1	74.7	763.7	2.220	0.	105.8	57.2
88	2	79.8	759.2	2.227	0.	107.4	60.1
88	3	78.9	741.7	2.231	0.	106.3	58.0
88	4	77.2	770.2	2.187	0.	107.7	60.3
89	1	87.9	700.0	2.258	0.002	109.5	59.5
89	2	89.2	661.4	2.262	0.003	108.7	56.7
89	3	90.7	707.7	2.272	0.001	109.1	61.1
90	1	95.6	640.2	2.268	0.004	109.5	57.5
90	2	100.7	667.3	2.287	0.005	109.3	61.7
90	3	94.7	708.6	2.289	0.004	109.9	62.6
90	4	103.8	718.6	2.279	0.005	109.4	68.1
91	1	102.5	628.0	2.288	0.009	110.8	58.8
91	2	102.6	608.8	2.285	0.007	111.0	57.1
91	3	105.6	606.5	2.285	0.008	110.9	58.1
91	4	96.2	601.8	2.286	0.005	111.6	53.9
92	1	102.5	607.5	2.307	0.012	111.1	56.4
92	2	117.8	572.8	2.285	0.007	111.4	59.5
92	3	100.1	629.1	2.285	0.011	111.3	57.9
92	4	110.5	588.8	2.287	0.007	111.5	58.2
97	1	77.8	762.4	2.473	0.005	108.2	53.1
98	1	92.6	718.6	2.236	0.006	111.6	64.0
98	2	90.2	717.4	2.360	0.011	110.5	59.4
98	3	92.4	722.0	2.375	0.007	109.9	60.4
125	1	104.6	644.2	2.613	0.002	112.2	53.6
125	2	99.4	752.0	2.598	0.003	112.5	60.6
99	1	95.7	737.8	2.491	0.006	110.6	60.4
99	2	88.9	665.3	2.461	0.008	109.9	52.3
100	1	93.8	716.2	2.330	0.008	111.0	61.7
100	2	101.8	685.1	2.328	0.009	111.3	62.7
100	3	103.7	679.4	2.350	0.009	111.7	62.4
100	4	98.4	675.4	2.321	0.007	112.4	60.5
101	1	106.5	688.6	2.432	0.013	111.7	62.3

PT NO	SC	POWER OUTPUT HP	POWER OUTPUT KW	CORRECTED SPEED RPM	CORRECTED TURBINE WORK BTU/LB	CORRECTED POWER KW	CORRECTED POWER HP
82	1	182	136	17755	55.9	177	238
82	2	192	143	18867	58.8	187	251
82	3	220	164	19601	67.3	215	289
82	4	173	129	17811	52.8	170	228
83	1	166	124	17319	50.8	160	214
83	2	169	126	16810	51.6	161	216
83	3	197	147	19604	60.5	188	252
83	4	196	146	19478	60.0	186	250
88	1	179	133	14821	57.2	176	236
88	2	189	141	15733	60.2	186	250
88	3	183	136	15576	58.1	180	242
88	4	186	139	15261	60.3	182	245
89	1	190	141	17139	59.6	188	252
89	2	181	135	17318	56.8	179	240
89	3	196	146	17513	61.2	195	261
90	1	184	137	18174	57.6	180	242
90	2	199	148	18853	61.7	192	258
90	3	202	151	18048	62.7	199	266
90	4	219	163	19287	68.2	216	289
91	1	190	141	19113	58.9	188	253
91	2	184	137	19129	57.2	183	246
91	3	187	140	19528	58.2	185	249
91	4	174	129	18254	53.9	171	229
92	1	184	137	19100	56.4	179	241
92	2	192	143	21178	59.6	189	253
92	3	187	139	18788	58.0	184	247
92	4	188	140	20192	58.4	186	250
97	1	185	138	15412	53.4	190	255
98	1	202	151	17746	63.9	189	253
98	2	198	148	17429	59.4	186	250
98	3	203	151	17718	60.4	191	256
125	1	198	147	19311	53.2	166	223
125	2	222	166	18594	60.1	184	246
99	1	212	158	18187	60.5	208	280
99	2	182	135	17300	52.5	185	248
100	1	203	151	17901	61.7	191	256
100	2	206	154	19001	62.7	199	267
100	3	207	154	19278	62.6	206	277
100	4	198	148	18521	60.4	183	245
101	1	214	159	19640	62.4	207	278

PT NO	SC	CORRECTED FLOW PPS	1ST STAGE WORK BTU/LB	2ND STAGE WORK BTU/LB	1ST STAGE PERCENT WORK	2ND STAGE PERCENT WORK	TOTAL TO TOTAL EFFICIENCY
82	1	3.013	14.6	41.2	26.17	73.83	0.513
82	2	3.022	16.1	42.7	27.41	72.59	0.542
82	3	3.040	18.0	49.2	26.82	73.18	0.612
82	4	3.054	14.0	38.7	26.57	73.43	0.483
83	1	2.985	13.0	37.8	25.62	74.38	0.472
83	2	2.964	13.5	38.2	26.15	73.85	0.478
83	3	2.950	15.6	44.9	25.81	74.19	0.538
83	4	2.947	15.8	44.3	26.26	73.74	0.540
88	1	2.922	14.5	42.7	25.31	74.69	0.540
88	2	2.940	15.2	45.0	25.22	74.78	0.560
88	3	2.945	15.1	42.9	26.08	73.92	0.546
88	4	2.877	16.1	44.2	26.67	73.33	0.560
89	1	2.994	14.7	44.8	24.76	75.24	0.544
89	2	2.991	13.9	42.8	24.53	75.47	0.522
89	3	3.019	16.0	45.1	26.20	73.80	0.560
90	1	2.973	15.0	42.5	26.11	73.89	0.525
90	2	2.961	15.8	45.9	25.55	74.45	0.564
90	3	3.009	15.5	47.1	24.72	75.28	0.569
90	4	3.001	16.9	51.3	24.76	75.24	0.623
91	1	3.037	14.6	44.2	24.84	75.16	0.531
91	2	3.046	14.2	42.9	24.85	75.15	0.514
91	3	3.026	14.8	43.2	25.51	74.49	0.523
91	4	3.007	13.8	40.0	25.68	74.32	0.483
92	1	3.019	14.3	42.0	25.41	74.59	0.508
92	2	3.007	15.8	43.6	26.64	73.36	0.534
92	3	3.012	14.4	43.5	24.90	75.10	0.521
92	4	3.030	14.8	43.5	25.35	74.65	0.522
97	1	3.388	12.8	40.3	24.08	75.92	0.491
98	1	2.803	15.9	48.1	24.85	75.15	0.573
98	2	2.982	14.7	44.8	24.65	75.35	0.538
98	3	3.008	14.9	45.5	24.66	75.34	0.550
125	1	2.968	13.1	40.5	24.39	75.61	0.478
125	2	2.902	14.8	45.8	24.41	75.59	0.539
99	1	3.273	14.7	45.7	24.35	75.65	0.546
99	2	3.341	12.5	39.8	23.98	76.02	0.476
100	1	2.936	15.8	45.9	25.61	74.39	0.556
100	2	3.012	15.3	47.4	24.41	75.59	0.563
100	3	3.129	15.5	47.0	24.76	75.24	0.559
100	4	2.874	15.2	45.3	25.17	74.83	0.538
101	1	3.154	15.6	46.7	25.03	74.97	0.558

PT NC	SC	TOTAL TO STATIC EFFICIENCY	TURBINE VELOCITY RATIO	EXPANSION EXPONENT
82	1	0.464	0.265	1.451
82	2	0.494	0.284	1.452
82	3	0.541	0.288	1.453
82	4	0.436	0.265	1.451
83	1	0.432	0.262	1.451
83	2	0.420	0.248	1.452
83	3	0.492	0.290	1.451
83	4	0.495	0.290	1.451
88	1	0.460	0.218	1.455
88	2	0.492	0.233	1.454
88	3	0.481	0.232	1.453
88	4	0.496	0.227	1.456
89	1	0.484	0.253	1.451
89	2	0.464	0.257	1.451
89	3	0.498	0.259	1.451
90	1	0.474	0.270	1.451
90	2	0.497	0.278	1.451
90	3	0.501	0.265	1.451
90	4	0.552	0.285	1.450
91	1	0.476	0.282	1.451
91	2	0.461	0.282	1.450
91	3	0.475	0.290	1.451
91	4	0.435	0.269	1.450
92	1	0.464	0.284	1.450
92	2	0.488	0.314	1.449
92	3	0.471	0.278	1.450
92	4	0.472	0.298	1.449
97	1	0.422	0.225	1.448
98	1	0.510	0.260	1.448
98	2	0.476	0.256	1.447
98	3	0.485	0.260	1.448
125	1	0.427	0.284	1.441
125	2	0.487	0.275	1.441
99	1	0.483	0.267	1.448
99	2	0.421	0.254	1.448
100	1	0.489	0.262	1.448
100	2	0.503	0.279	1.449
100	3	0.499	0.282	1.449
100	4	0.484	0.272	1.447
101	1	0.502	0.289	1.448

TABLE VI (Cont'd)

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

Test Date:	Oct. 8, 1964
Nominal Inlet Temperature, °F:	1550
Nominal Inlet Quality, Percent:	99
Total to Total Pressure Ratio:	3.756 to 4.172

TWO-STAGE POTASSIUM TURBINE PERFORMANCE

DATE	PT NO	SC	TURBINE INLET TEMP DEG F	SPEED RPM	TOTAL TO TOTAL PRESSURE RATIO	TOTAL TO STATIC PRESSURE RATIO	SUPPLIED VAPOR QUALITY	INLET VAPOR QUALITY
1008.64	101	2	1526	19977	4.019	4.807	0.981	0.981
1008.64	106	1	1541	15527	3.947	4.992	0.980	0.980
1008.64	106	2	1544	16380	3.925	4.938	0.980	0.980
1008.64	106	3	1547	17212	3.978	4.972	0.979	0.979
1008.64	106	4	1543	15309	3.978	5.032	0.980	0.980
1008.64	107	1	1543	17415	3.997	4.989	0.979	0.979
1008.64	107	2	1544	16806	3.881	4.931	0.979	0.979
1008.64	107	3	1542	16236	4.024	4.954	0.979	0.979
1008.64	107	4	1543	16128	3.892	4.967	0.980	0.980
1008.64	108	1	1541	17217	3.960	5.004	0.979	0.979
1008.64	108	2	1542	18341	4.066	5.001	0.979	0.979
1008.64	108	3	1542	18070	3.966	4.917	0.979	0.979
1008.64	108	4	1545	15527	3.756	4.935	0.979	0.979
1008.64	109	1	1544	19491	4.094	4.919	0.979	0.979
1008.64	109	2	1546	19116	4.172	5.020	0.979	0.979
1008.64	109	3	1542	18461	4.163	4.956	0.979	0.979
1008.64	109	4	1543	18233	4.082	4.931	0.979	0.979
1008.64	110	1	1543	19525	4.013	4.926	0.978	0.978
1008.64	110	2	1541	20327	4.093	4.841	0.979	0.979
1008.64	110	3	1541	19331	4.091	4.818	0.979	0.979
1008.64	110	4	1541	20687	4.007	4.850	0.979	0.979

PT NO	SC	EXIT VAPOR QUALITY	SUPPLY TOTAL PRESSURE PSIA	INLET TOTAL PRESSURE PSIA	EXIT TOTAL PRESSURE PSIA	DOWN STREAM TOTAL PRESSURE PSIA	SUPPLY STATIC PRESSURE PSIA
101	2	0.929	28.32	28.30	7.05	2.94	28.23
106	1	0.934	30.19	30.05	7.65	2.76	30.07
106	2	0.933	30.15	29.94	7.68	2.81	30.05
106	3	0.928	30.56	30.58	7.68	2.67	30.49
106	4	0.940	30.33	30.28	7.62	2.61	30.26
107	1	0.933	30.37	30.33	7.60	2.59	30.26
107	2	0.934	29.82	29.70	7.68	2.56	29.84
107	3	0.954	30.25	30.04	7.52	2.67	30.16
107	4	0.935	30.23	29.86	7.77	2.65	30.16
108	1	0.936	30.17	30.30	7.62	2.56	30.00
108	2	0.930	30.15	29.94	7.41	2.57	30.03
108	3	0.934	30.03	29.95	7.57	2.56	29.89
108	4	0.940	30.14	30.01	8.02	2.57	29.98
109	1	0.937	30.62	30.55	7.48	2.67	30.48
109	2	0.939	30.66	30.44	7.35	2.61	30.48
109	3	0.940	30.56	30.65	7.34	2.57	30.36
109	4	0.940	30.50	30.42	7.47	2.52	30.40
110	1	0.930	30.28	30.03	7.55	2.61	30.23
110	2	0.932	29.75	29.90	7.27	2.62	29.41
110	3	0.934	30.09	30.01	7.35	2.59	30.01
110	4	0.928	29.81	29.49	7.44	2.50	29.70

PT NO	SC	TIP INLET STATIC PRESSURE PSIA	HUB INLET STATIC PRESSURE PSIA	1ST NOZ TIP EXIT STATIC PRESSURE PSIA	1ST NOZ HUB EXIT STATIC PRESSURE PSIA	1ST ROTOR TIP EXIT STATIC PRESSURE PSIA	1ST RCTOR HUB EXIT STATIC PRESSURE PSIA
101	2	27.12	27.04	22.12	19.96	16.04	18.77
106	1	28.85	28.84	24.28	22.48	17.87	20.94
106	2	29.14	28.92	24.43	22.64	18.01	20.80
106	3	29.24	29.23	24.80	22.99	18.14	21.28
106	4	29.00	28.92	24.61	22.54	18.01	21.12
107	1	29.30	29.28	24.80	23.01	17.79	20.90
107	2	29.33	28.91	24.91	23.36	17.97	20.63
107	3	29.22	29.04	24.75	22.73	17.93	20.80
107	4	29.33	29.06	24.76	22.75	18.14	21.12
108	1	29.29	29.25	24.88	22.81	17.93	21.00
108	2	28.87	28.91	24.43	22.54	17.93	20.72
108	3	28.78	28.72	24.66	22.69	18.05	21.16
108	4	28.82	29.10	24.74	22.71	17.91	20.86
109	1	29.13	29.28	25.16	23.11	18.20	21.41
109	2	29.47	29.43	25.10	23.17	18.42	21.32
109	3	29.32	29.38	24.92	22.99	18.10	21.43
109	4	29.26	29.28	25.03	22.99	18.14	21.10
110	1	29.31	29.14	24.87	22.56	17.93	20.49
110	2	28.56	28.62	24.00	22.04	17.14	19.94
110	3	28.95	29.04	24.25	22.00	17.12	19.92
110	4	28.54	28.48	24.08	21.95	16.98	19.74

PT NO	SC	2ND NOZ HUB EXIT STATIC PRESSURE PSIA	2ND ROTOR HUB EXIT STATIC PRESSURE PSIA	DOWN STREAM STATIC PRESSURE PSIA	DOWN STREAM TAYLOR STATIC PRESSURE PSIA	INLET CALORI-METER PRESSURE PSIA	INLET CALORI-METER TEMP DEG F
101	2	9.75	5.89	2.72	4.18	3.07	1166
106	1	9.99	6.05	2.46	3.48	2.90	1158
106	2	9.87	6.11	2.40	3.41	2.86	1157
106	3	10.05	6.15	2.22	3.42	2.86	1156
106	4	9.99	6.03	2.37	3.37	2.80	1155
107	1	10.22	6.09	2.36	3.28	2.84	1153
107	2	10.15	6.05	2.33	3.43	2.84	1153
107	3	9.99	6.11	2.38	3.55	2.84	1155
107	4	9.99	6.09	2.42	3.39	2.86	1157
108	1	10.13	6.03	2.36	3.50	2.84	1154
108	2	9.93	6.03	2.32	3.34	2.84	1152
108	3	10.09	6.11	2.32	2.81	2.80	1152
108	4	10.09	6.11	2.26	3.65	2.86	1153
109	1	10.42	6.23	2.44	3.76	2.95	1158
109	2	10.32	6.11	2.35	3.32	2.86	1157
109	3	10.32	6.17	2.32	3.56	2.82	1155
109	4	10.30	6.19	2.30	3.31	2.78	1152
110	1	10.01	6.15	2.34	3.83	2.88	1152
110	2	10.18	6.15	2.33	3.63	2.84	1153
110	3	9.93	6.24	2.25	3.60	2.86	1152
110	4	10.11	6.15	2.24	3.60	2.82	1150

PT NO	SC	EXIT TEMP DEG F	1ST STAGE HUB REACTION	1ST STAGE TIP REACTION	2ND STAGE HUB REACTION	MAIN TORQUE READING IN-LB	SECONDARY TORQUE READING IN-LB
101	2	1170	0.144	0.554	0.385	648.9	113.8
106	1	1172	0.189	0.574	0.354	674.5	7.3
106	2	1176	0.222	0.581	0.344	641.2	6.6
106	3	1176	0.209	0.589	0.348	652.9	6.2
106	4	1180	0.175	0.588	0.353	617.3	7.4
107	1	1166	0.251	0.611	0.372	627.7	47.1
107	2	1167	0.331	0.635	0.373	641.5	45.2
107	3	1172	0.231	0.606	0.354	461.8	55.5
107	4	1176	0.203	0.599	0.350	666.6	44.9
108	1	1189	0.223	0.619	0.368	619.8	58.5
108	2	1170	0.218	0.585	0.357	603.9	22.8
108	3	1176	0.195	0.603	0.356	636.8	84.6
108	4	1191	0.226	0.610	0.358	636.3	56.7
109	1	1178	0.208	0.612	0.370	633.0	118.0
109	2	1177	0.224	0.597	0.373	614.8	102.1
109	3	1179	0.193	0.600	0.368	625.0	102.0
109	4	1173	0.227	0.609	0.369	628.5	98.5
110	1	1175	0.240	0.614	0.358	652.4	116.7
110	2	1175	0.245	0.599	0.382	617.6	115.7
110	3	1172	0.235	0.606	0.356	627.7	111.4
110	4	1175	0.250	0.609	0.376	626.7	112.5

PT NO	SC	TARE TORQUE READING IN-LB	TOTAL TORQUE READING IN-LB	EMFM FLOW PPS	SPRAY FLOW PPS	TURBINE IDEAL DROP BTU/LB	TURBINE WORK BTU/LB
101	2	109.0	644.2	2.438	0.009	112.2	59.2
106	1	78.7	745.9	2.441	0.002	111.3	53.2
106	2	83.5	718.1	2.435	0.001	110.8	54.2
106	3	88.6	735.3	2.438	0.003	111.9	58.2
106	4	77.4	687.4	2.445	0.001	111.8	48.3
107	1	90.1	670.6	2.444	0.005	112.1	53.6
107	2	85.9	682.2	2.438	0.002	109.9	52.7
107	3	82.7	489.0	2.449	0.005	112.6	36.4
107	4	82.1	703.8	2.449	0.005	110.2	52.0
108	1	88.6	649.9	2.448	0.003	111.4	51.3
108	2	96.9	678.0	2.465	0.008	113.3	56.6
108	3	94.9	647.1	2.460	0.009	111.5	53.3
108	4	78.7	658.3	2.422	0.007	107.5	47.3
109	1	105.4	620.4	2.674	0.007	113.9	50.7
109	2	102.7	615.3	2.673	0.005	115.4	49.4
109	3	97.8	620.8	2.658	0.005	115.1	48.4
109	4	96.1	626.1	2.667	0.009	113.7	48.0
110	1	105.7	641.4	2.510	0.013	112.3	55.9
110	2	111.6	613.5	2.518	0.010	113.7	55.5
110	3	104.3	620.5	2.535	0.015	113.7	53.1
110	4	114.3	628.5	2.530	0.009	112.1	57.6

PT NO	SC	POWER OUTPUT HP	POWER OUTPUT KW	CORRECTED SPEED RPM	CORRECTED TURBINE WORK BTU/LB	CORRECTED POWER KW	CORRECTED POWER HP
101	2	204	152	20005	59.4	203	272
106	1	183	137	15515	53.1	170	229
106	2	186	139	16360	54.0	171	230
106	3	200	149	17184	58.0	182	244
106	4	166	124	15294	48.2	154	207
107	1	185	138	17399	53.5	171	229
107	2	181	135	16787	52.6	167	224
107	3	125	93	16223	36.3	116	156
107	4	180	134	16110	51.9	165	222
108	1	177	132	17204	51.2	165	221
108	2	197	147	18327	56.5	182	245
108	3	185	138	18055	53.2	171	230
108	4	162	120	15508	47.2	148	198
109	1	191	143	19468	50.6	176	236
109	2	186	139	19087	49.2	169	227
109	3	181	135	18444	48.3	168	225
109	4	181	135	18216	47.9	167	224
110	1	198	148	19509	55.8	183	246
110	2	197	147	20313	55.5	184	247
110	3	190	141	19320	53.0	177	237
110	4	206	153	20676	57.6	192	258

PT NO	SC	CORRECTED FLOW PPS	1ST STAGE WORK BTU/LB	2ND STAGE WORK BTU/LB	1ST STAGE PERCENT WORK	2ND STAGE PERCENT WORK	TOTAL TO TOTAL EFFICIENCY
101	2	3.245	14.8	44.4	24.93	75.07	0.527
106	1	3.050	11.3	41.9	21.32	78.68	0.478
106	2	3.009	11.9	42.2	22.06	77.94	0.489
106	3	2.974	12.4	45.8	21.30	78.70	0.520
106	4	3.038	10.0	38.2	20.76	79.24	0.432
107	1	3.032	12.0	41.6	22.33	77.67	0.478
107	2	3.012	11.9	40.9	22.47	77.53	0.480
107	3	3.052	7.9	28.4	21.85	78.15	0.323
107	4	3.031	11.0	40.9	21.25	78.75	0.472
108	1	3.057	11.2	40.1	21.81	78.19	0.460
108	2	3.068	12.5	44.1	22.12	77.88	0.499
108	3	3.060	10.9	42.4	20.53	79.47	0.478
108	4	2.979	10.5	36.9	22.13	77.87	0.440
109	1	3.300	10.6	40.1	20.91	79.09	0.445
109	2	3.272	10.5	38.9	21.19	78.81	0.428
109	3	3.304	10.1	38.3	20.84	79.16	0.420
109	4	3.312	10.4	37.6	21.76	78.24	0.422
110	1	3.118	13.2	42.8	23.55	76.45	0.498
110	2	3.151	13.5	42.0	24.39	75.61	0.488
110	3	3.173	13.5	39.6	25.38	74.62	0.467
110	4	3.169	14.3	43.3	24.87	75.13	0.514

PT NO	SC	TOTAL TO STATIC EFFICIENCY	TURBINE VELOCITY RATIO	EXPANSION EXPONENT
101	2	0.474	0.293	1.449
106	1	0.416	0.225	1.447
106	2	0.426	0.238	1.447
106	3	0.456	0.250	1.446
106	4	0.376	0.221	1.446
107	1	0.419	0.253	1.446
107	2	0.416	0.245	1.446
107	3	0.285	0.236	1.446
107	4	0.407	0.234	1.447
108	1	0.400	0.250	1.446
108	2	0.442	0.266	1.445
108	3	0.421	0.263	1.446
108	4	0.373	0.226	1.445
109	1	0.399	0.284	1.446
109	2	0.384	0.277	1.446
109	3	0.379	0.268	1.446
109	4	0.378	0.265	1.446
110	1	0.441	0.284	1.445
110	2	0.442	0.297	1.446
110	3	0.423	0.283	1.446
110	4	0.459	0.303	1.445

TABLE VII

TEST INSTRUMENTATION

Quantity	Location	Item No.	Sensor	Range
Nozzle Inlet Total Pressure	Nozzle Inlet-Outer of Rake	18	Pressure Transducer	0-20 Psid
Nozzle Inlet Total Pressure	Nozzle Inlet Mid Stream Rake	19	Pressure Transducer	0-20 Psid
Nozzle Inlet Total Pressure	Nozzle Inlet Inner of Rake	20	Pressure Transducer	0-20 Psid
Nozzle Inlet Total Pressure	Nozzle Inlet Mid Stream	21	Pressure Transducer	0-20 Psid
Nozzle Inlet Static Pressure	Nozzle Flow Passage Tip	26	Pressure Transducer	0-10 Psid
Nozzle Inlet Static Pressure	Nozzle Flow Passage Hub	27	Pressure Transducer	0-10 Psid
Total Pressure	Calibrated Nozzle Inlet		Pressure Transducer	0-20 Psid
Total Pressure	Calibrated Nozzle Inlet		Pressure Transducer	0-20 Psid
Total Temperature	Calibrated Nozzle Inlet		T/C	100°F
Total Temperature	Calibrated Nozzle Inlet		T/C	100°F
Total-Static Pressure	Calibrated Nozzle Inlet		Pressure Transducer	0-10 Psid
Total-Static Pressure	Calibrated Nozzle Exit		Pressure Transducer	0-10 Psid
Total Temperature	Calibrated Nozzle Inlet		T/C	100°F
Total Temperature	Calibrated Nozzle Exit		T/C	100°F
Differential Pressure	Turbine Test Station #3	21-25	Differential Pressure Transducer	0-1.5 Psid
Differential Pressure	Turbine Test Station #3	20-24	Differential Pressure Transducer	0-5 Psid
Differential Pressure	Turbine Test Station #3	19-23	Differential Pressure Transducer	0-5.0 Psid
Differential Pressure	Turbine Test Station #3	18-22	Differential Pressure Transducer	0-5 Psid

TABLE VIII

BULLET NOSE ANNULUS CALIBRATION TEST SCHEDULE

Point No.	Inlet Pressure, Psia	Approximate Flow, pps
1	31.0	4.5
2	29.0	4.2
3	27.0	3.9
4	25.0	3.5
5	23.0	3.2
6	21.0	2.7
7	19.0	2.2
8	17.0	1.5

TABLE IX

TORQUE MEASUREMENT

	PERFORMANCE TEST		TARE TEST		
	K Turbine Torque Meter	Steam Turbine Torque Meter	Steam Turbine Torque Meter	K Turbine Torque Meter	TOTAL
Full Scale Reading	2500	200	200	2500	
Accuracy, % of Full Scale	.5	1.0	1.0	.5	
Maximum Error, in-lbs.	13	2	2	13	30
Typical Reading, in-lbs	432	-101	156	-52	435
Error, %	2.99	.46	.46	2.99	6.90

TABLE X

TORQUE MEASUREMENT ACCURACY

	Performance Tests		Tare Tests		
	Potassium Turbine Torque Meter	Steam Turbine Torque Meter	Steam Turbine Torque Meter	Alternate K Turbine Torque Meter	TOTAL
Full Scale Reading, in-lbs.	1500	200	200	375	
Accuracy, % of Full Scale	.5	1.0	1.0	.5	
Maximum Error, in-lbs.	7.5	2	2	1.9	13.4
Typical Reading, in-lbs.	432	-101	156	-52	435
Errors, %	1.72	.46	.46	.44	3.08

TABLE XI

PROPOSED POTASSIUM VAPOR TURBINE TEST INSTRUMENTATION

Item No.	Parameter	Location	Station	Range	Sensor	Control Room Readout
1	Vapor Total Temp., °F	045-1	1	1400-1650°F	CA T/C	Digital
2	Vapor Total Temp., °F	135-1	1	1400-1650°F	CA T/C	Digital
3	Vapor Total Temp., °F	235-1	1	1432-1682°F	CA T/C	Sanborn
4	Vapor Total Temp., °F	315-1	1	1400-1650°F	CA T/C	Digital
5	Vapor Total Temp., °F	315-2	1	1400-1650°F	CA T/C	Digital
6	(Reference) Vapor Total Pressure	360-1	1	0-50 psia	Efflux	Digital
7	Vapor Total Pressure	360-2	1	0-50 psia	Efflux	Digital
8	(Alternate Reference) Vapor Total Pressure	360-3	1	0-50 psia	Efflux	Digital
9	Vapor Total Pressure	065-1	1	0-50 psia	Efflux	Digital
10	Vapor Total Pressure	300-1	1	0-50 psia	Efflux	Digital
11	Vapor Static Pressure	080-1	1	0-50 psia	Efflux	Digital
12	Vapor Static Pressure	280-1	1	0-50 psia	Efflux	Digital
13	Calorimeter Temp., °F	Calorimeter 010-1	1	1400-1650°F	CA T/C	Digital
14	Calorimeter Pressure	Calorimeter 010-1	1	0-50 psia	Efflux	Digital
15	Spray Liquid Temp., °F	Liquid Injector	2	1432-1682°F	CA T/C	Digital
16	Spray Liquid Pressure	Liquid Injector	2	0-150 psig	Statham & Taylor Gage	Digital
17	Spray Liquid Flow	Liquid Injector	2	0-10 MV See Curve	EMFM	Digital
18	Vapor Total Pressure	Inlet Duct 292-1	3	0-50 psia	Efflux	Digital
19	Vapor Total Pressure	Inlet Duct 286-2	3	0-50 psia	Efflux	Digital
20	Vapor Total Pressure	Inlet Duct 280-3	3	0-50 psia	Statham on Efflux	Digital
21	Vapor Total Pressure	Inlet Duct 074-1	3	0-50 psia	Efflux	Sanborn & Digital

TABLE XI (CONTINUED)

PROPOSED POTASSIUM VAPOR TURBINE TEST INSTRUMENTATION

Item No.	Parameter	Location	Station	Range	Sensor	Control Room Readout
22	Vapor Static Pressure	Inlet Inner 090-1	3	0-50 psia	Efflux	Digital
23	Vapor Static Pressure	Inlet Outer 270-1	3	0-50 psia	Efflux	Digital
24	Vapor Static Pressure	Inlet Inner 270-1	3	0-50 psia	Efflux	Digital
25	Vapor Static Pressure	Inlet Outer 090-1	3	0-50 psia	Efflux	Digital
26	Vapor Static Pressure	Upstr. Rotor 1-Tip 082-1	4	0-50 psia	Efflux	Digital
27	Vapor Static Pressure	Upstr. Rotor 1-Hub 082-1	4	0-50 psia	Efflux	Digital
28	Vapor Temperature	Wheel Space 120-1	4	650-1650°F	CA T/C	Digital
29	Vapor Temperature	Wheel Space 330	4	650-1650°F	CA T/C	Digital
30	Vapor Static Pressure	Upstr. Nozzle 2-Tip 270-1	5	0-50 psia	Efflux	Digital
31	Vapor Static Pressure	Upstr. Nozzle 2-Hub 270-1	5	0-50 psia	Efflux	Digital
32	Vapor Temperature		5	650-1650°F	CA T/C	Deleted
33	Vapor Temperature		5	650-1650°F	CA T/C	Deleted
34	Vapor Static Pressure	Upstr. Rotor 2-Tip 282-1	6	0-50 psia	Efflux	Digital
35	Vapor Static Pressure	Upstr. Rotor 2-Hub 278-1	6	0-50 psia	Efflux	Digital
36	Vapor Temperature		6	650-1650°F	CA T/C	Deleted
37	Vapor Temperature		6	650-1650°F	CA T/C	Deleted
38	Vapor Total Pressure	Upstr. OGV 300-1	7	0-50 psia	Efflux	Digital
39	Vapor Total Pressure	Upstr. OGV 300-2	7	0-50 psia	Efflux	Digital
40	Vapor Total Pressure	Upstr. OGV 300-3	7	0-50 psia	Efflux	Digital
41	Vapor Total Pressure	Upstr. OGV 79-1	7	0-50 psia	Efflux	Digital
42	Vapor Static Pressure	Upstr. OGV Tip 063-1	7	0-50 psia	Efflux	Digital

TABLE XI (Cont'd)

PROPOSED POTASSIUM VAPOR TURBINE TEST INSTRUMENTATION

Item No.	Parameter	Location	Station	Range	Sensor	Control Room Readout
43	Vapor Static Pressure	Upstr. OGV Hub 063-1	7	0-50 psia	Efflux	Digital
44	Vapor Static Pressure	Upstr. OGV Tip 284-1	7	0-50 psia	Efflux	Digital
45	Vapor Static Pressure	Upstr. OGV Hub 284-1	7	0-50 psia	Statham Efflux	Digital
46	Vapor Temperature	OGV 128	7	650-1650°F	CA T/C	Digital
47	Vapor Temperature	OGV 142	7	650-1650°F	CA T/C	Sanborn Digital
48	Vapor Temperature	OGV 156	7	650-1650°F	CA T/C	Digital
49	Vapor Temperature	OGV 230	7	650-1650°F	CA T/C	Digital
50	Vapor Temperature	OGV 45	7	650-1650°F	CA T/C	Digital
51	Vapor Temperature	OGV 308	7	650-1650°F	CA T/C	Digital
52	Vapor Temperature	SW-1	8	650-1650°F	CA T/C	Digital
53	Vapor Temperature	SW-2	8	650-1650°F	CA T/C	Digital
54	Vapor Temperature	SE-1	8	650-1650°F	CA T/C	Digital
55	Vapor Temperature	NE-1	8	650-1650°F	CA T/C	Digital
56	Vapor Temperature	NW-1	8	650-1650°F	CA T/C	Digital
57	Vapor Total Pressure	S-1	8	0-50 psia	Efflux	Digital
58	Vapor Total Pressure	S-2	8	0-50 psia	Efflux	Digital
59	Vapor Total Pressure	S-3	8	0-50 psia	Efflux	Digital
60	Vapor Total Pressure	W-1	8	0-50 psia	Efflux	Digital
61	Vapor Total Pressure	E-1	8	0-50 psia	Efflux	Digital
62	Deleted to No. 160 Vapor Static Pressure	N-1 Main Cond.	8	0-50 psia	Taylor Statham	Digital &Sanborn
63	Vapor Static Pressure	SE	8	0-50 psia	Efflux	Digital

TABLE XI (Cont'd)

PROPOSED POTASSIUM VAPOR TURBINE TEST INSTRUMENTATION

Item No.	Parameter	Location	Station	Range	Sensor	Control Room Readout
64	Vapor Static Pressure	NE	8	0-50 psia	Efflux	Digital
65	Calorimeter Insulation Temperature	T/C 122 Exit Superheater	8	1150-1650°F	CA T/C	Digital
66	Calorimeter Insulation Temperature	T/C 123 Exit Superheater	8	1150-1650°F	CA T/C	Digital
67	Calorimeter Insulation Temperature	T/C 124 Exit Superheater	8	1150-1650°F	CA T/C	Digital
68	Calorimeter Insulation Temperature	T/C 125 Exit Superheater	8	1150-1650°F	CA T/C	Digital
69	Calorimeter Insulation Temperature	T/C 126 Exit Superheater	8	1150-1650°F	CA T/C	Digital
70	Calorimeter Insulation Temperature	T/C 127 Exit Superheater	8	1150-1650°F	CA T/C	Digital
71	Calorimeter Insulation Temperature	T/C 128 Exit Superheater	8	1150-1650°F	CA T/C	Digital
72	Calorimeter Insulation Temperature	T/C 129 Exit Superheater	8	1150-1650°F	CA T/C	Digital
73	Calorimeter Pressure	Aft Htr. "A"	8	0-50 psia	Efflux	Digital
74	Calorimeter Pressure	Aft Htr. "B"	8	0-50 psia	Efflux	Digital
75	Calorimeter Temp.	Aft Htr. "A"	8	1150-1650°F	CA T/C	Digital
76	Calorimeter Temp.	Aft Htr. "B"	8	1150-1650°F	CA T/C	Digital
77	Insulation Temperature	Compensating Heater	1	1150-1650°F	CA T/C	Digital
78	Insulation Temperature	Compensating Heater	1	1150-1650°F	CA T/C	Digital
79	Insulation Temperature	Compensating Heater	1	1150-1650°F	CA T/C	Digital
80	Insulation Temperature	Compensating Heater	1	1150-1650°F	CA T/C	Digital
81	Condenser Liquid Level	Condenser	11	0-6 inches	Ohmart & Brown	Sanborn
82	Main Condenser Flow	Main EMFM	11	0-10 MV	EMFM	Sanborn &Digital
83	Flow Temp. of Main Condenser	Main EMFM	11	432-932°F	CA T/C	Sanborn &Digital
84	Spray EMFM Temp. At Flowmeter	Spray EMFM		432-932°F	CA T/C	Digital

TABLE XI (Cont'd)

PROPOSED POTASSIUM VAPOR TURBINE TEST INSTRUMENTATION

Item No.	Parameter	Location	Station	Range	Sensor	Control Room Readout
85	Speed (Berkeley)	Steam Turbine	11	0-25,000 rpm	Magnetic Pickup	Berkeley
86	Speed (Sanborn & Digital)	Steam Turbine	11	0-25,000 rpm	Magnetic Pickup	Sanborn &Digital
87	Steam Turbine Torque	Steam Turbine	11	0-200 in/lbs	Bytrex	Digital
88	Potassium Turbine Torque	Glove Box	11	0-100 lbs	Loadcell	Dial & Sanborn Digital
89	Condenser Liquid Temperature	Condenser	11	300-1300°F	CA T/C	Digital
90	R.T.D. C.A.T.S. Block Temperature	CATS Block		5.6 MV	R.T.D.	Digital
91	Vapor Static Pressure Compliment of No. 26	Upstr. Rotor-1 Tip 280-1	4	0-50 psia	Efflux	Deleted
92	Vapor Static Pressure Compliment of No. 27	Upstr. Rotor-1 Hub 280-1	4	0-50 psia	Efflux	Deleted
93	Transducer P-s 5.0 Volts			5.0 Volts		Digital
94	Standard Resistor R70 Network			5.6 MV		Digital
	T U R B I N E P A D	B E A R I N G				
95	Pad Bearing Temp. Pad #2	Pad Bearing		250°F	CA T/C	TR #3-1
96	Pad Bearing Temp. Pad #2	Pad Bearing		250°F	CA T/C	TR #3-2
97	Pad Bearing Temp. Pad #1	Pad Bearing		250°F	CA T/C	TR #3-3
98	Pad Bearing Temp. Pad #5	4-R Pad			CA T/C	Sanborn
99	Pad Bearing Cavity Temperature				CA T/C	TR #3-4
100	Pad Bearing Lube Inlet Pressure	Pad Bearing			Gauge	Visual & Wrng.Sig.
101	Pad Bearing Lube Flow	Pad Bearing		0-200" H_2O (3 gpm)	Foxboro D.P. Cell	Sanborn
102	"K" Turbine Bearing Lube Temperature Out			250°F	CA T/C	Digital TR #3-5
103	"K" Turbine Bearing Lube Temperature In			250°F	CA T/C	Digital TR #3-6
104	Stabilizer Bearing Temperature			250°F	CA T/C	TR #3-7

TABLE XI (Cont'd)

PROPOSED POTASSIUM VAPOR TURBINE TEST INSTRUMENTATION

Item No.	Parameter	Location	Station	Range	Sensor	Control Room Readout
	TURBINE BALL BEARING					
105	Rear Ball Thrust Bearing Temperature			32-282°F	CA T/C	Sanborn
106	Forward Ball Thrust Bearing Temperature			250°F	CA T/C	Sanborn & TR #3-8
107	Ball Bearing Lube Oil Pressure In			200 psig	Bourdon Gauge	Visual & Wrng.Sig.
108	Ball Bearing Lube Oil Flow			0-200" H_2O (3 gpm)	Foxboro D.P. Cell	Sanborn
	STEAM TURBINE BEARING					
109	Temp. Steam Turbine Bearing Forward			250°F	CA T/C	TR #3-9
110	Temp. Steam Turbine Bearing Middle			250°F	CA T/C	TR #3-10
111	Temperature Steam Turbine Bearing Aft			250°F	CA T/C	TR #3-11
112	Temperature Steam Turbine Lube In			250°F	CA T/C	TR #3-12
113	Temperature Steam Turbine Lube Out			250°F	CA T/C	TR #3-13
114	Steam Turbine Lube Oil Pressure			80 psig	Bourdon Gauge	Warning Light
115	Steam Turbine & H_2O Brake Lube Oil Flow			1 gpm	Flow-rator	Warning Light
	WATER BRAKE					
116	H_2O Brake, Water Inlet Temperature			60°F	CA T/C	TR #3-14 Digital
117	H_2O Brake, Water Outlet Temperature			150°F	CA T/C	Digital TR #3-15
118	Temperature H_2O Brake Bearing Forward			180°F	CA T/C	TR #3-16
119	Temperature H_2O Brake Bearing Aft			180°F	CA T/C	TR #3-17
120	H_2O Brake; Water Flow			0-50 gpm	D.C. Generator	Gauge
121	H_2O Brake; Lube Oil Flow			1 gpm	Flow-rator	Warning Light

TABLE XI (Cont'd)

PROPOSED POTASSIUM VAPOR TURBINE TEST INSTRUMENTATION

Item No.	Parameter	Location	Station	Range	Sensor	Control Room Readout
	V I B R A T I O N					
122	Displacement Steam Turbine Aft Bearing Vert.			0-5 mils	Vib.P/U	Sanborn
123	Displacement Steam Turbine Aft Bearing Hor.			0-5 mils	Vib.P/U	Sanborn
124	Displacement Aft "K" Turbine Vertical			0-5 mils	Vib.P/U	Sanborn
125	Displacement Aft "K" Turbine Horizontal			0-5 mils	Vib.P/U	Sanborn
126	Accel. Pad Bearing Vertical			0-10 g's	Accel.	Visual
127	Accel. Pad Bearing Horizontal			0-10 g's	Accel.	Visual
	H Y D R O D Y N A M I C	S E A L				
128	Temp. Seal "K" In			500°F	CA T/C	Digital & TR#3-18
129	Temp. Seal "K" Out			1000°F	CA T/C	Digital & TR#3-43
130	Slinger Seal Turbine Inlet Pressure P-11			0-150 psig	Taylor Gauge	Visual
131	P-6 Oil Side Seal Pressure			0-30 psig	Taylor Gauge	Visual
132	"K" Seal Flow			0-5 MV See Curve	Pace + EMFM	Flow Rec. &Digital
133	Temp. Argon Seal In			500°F	CA T/C	TR#3
134	Turbine Argon Inlet Pressure P-7	Lab.Seal Inlet at Man.		100 psig	Pressure Gauge	Visual
135	Bearing Sump Wall Temperature			500°F	CA T/C	Multipt. Rec.
136	Lube Cart Pressure Out			200 psig	Gauge	Visual
137	Stabilizer Bearing Lube Pressure			200 psig	Gauge	Visual
138	Stabilizer Bearing Piston Actuating Pressure			200 psig	Gauge	Visual
139	P-8 Potassium Side Seal Pressure			-30" Hg to 100 psig	Taylor & Statham	Sanborn &Visual
140	Argon Header Press.P-1			0-60 psig	Taylor Gauge	Visual

TABLE XI (Cont'd)

PROPOSED POTASSIUM VAPOR TURBINE TEST INSTRUMENTATION

Item No.	Parameter	Location	Station	Range	Sensor	Control Room Readout
141	Argon Extraction Flow	Downstream of VPL-8	11	0-10 MV See Curve	EMFM	Sanborn
142	Boiler Feed Pressure	Boiler Inlet			Wiancko & Tylr.Gage	Sanborn
143	Turbine Shaft 270° Movement Radial	Stabilizer Bearing			Bently Gage	Oscillo-Scope
144	Turbine Bearing Housing Temp.(Fwd)	Bearing Housing	Section E		CA T/C	TR #1-4
145	Turbine Bearing Housing Temp.(Aft)	Bearing Housing	Section F		CA T/C	TR #1-13
146	Turbine Casing Fwd.Temperature	Turbine Casing	3	1400°F	CA T/C	Multipt. Rec.
147	Turbine Casing Aft. Temperature	Turbine Casing	5	1400°F	CA T/C	Multipt. Rec.
148	8" Vapor Line Temp.	6"Aft of Spray Line	2	1400°F	CA T/C	Multipt. Rec.
149	8" Vapor Line Temp.	14"Aft of Spray Line	2	1400°F	CA T/C	Multipt. Rec.
150	Pad Bearing Ring Temp. #1 T/C 24°	Pad Bearing Ring			CA T/C	TR #3-19
151	Pad Bearing Ring Temp. #2 T/C 50°	Pad Bearing Ring			CA T/C	TR #3-20
152	Bullet Nose Delta-P	Between Items #21 & 25	3	0-1.5 psid	Efflux & Pace P3	Digital &Sanborn
153	Turbine Delta-P	Between Items #18 & 41	3 & 7	0-50 psid	Efflux & Pace P3	Digital &Sanborn
154	Boiler Feed Temperature	At Boiler Feed EMFM			CA T/C	Sanborn
155	Boiler Feed Flow	Boiler Input		----	EMFM	Sanborn
156	Exit Calorimeter Htr. "B" Power Input	Exit Calorimeter	8	0-5 KW	Hall X-Ducer	Dial & Digital
157	Exit Calorimeter Htr. "A" Power Input	Exit Calorimeter	8	0-5 KW	Hall X-Ducer	Dial & Digital
158	Compensating Heater Power Input	Compensating Heater	2	0-5 KW	Hall X-Ducer	Dial & Digital
159	Vapor Static Pressure		1		Taylor & Pace	Digital
160	Vapor Static Pressure		7		Taylor & Statham	&Digital
161	Turbine Shaft Movement Radial (180°)	Stabilizer Bearing			Bently Gage	Oscillo-Scope

TABLE XI (Cont'd)

PROPOSED POTASSIUM VAPOR TURBINE TEST INSTRUMENTATION

Item No.	Parameter	Location	Station	Range	Sensor	Control Room Readout
162	Boiler Liquid Level	Boiler			"J" Tube	Sanborn
163	Boiler Liquid Level	Boiler			Ohmart Gage	Recorder + Dial
164	VPL-11 Valve Stem Position	VPL-11			Linear Motion Pot.	Sanborn
165	Water Brake Valve Stem Position	Water Brake Valve			Linear Motion Pot.	Sanborn
166	Boiler Discharge Temperature (Skin)	Upstream of VPL-11		1650°F	Skin CA T/C	Sanborn &Digital
167	Vapor Temperature	Midstream 022°	3	1650°F	CA T/C	Digital
168	Water Brake Forward Vibration Vertical	Water Brake			Vib. P/U	G.E. Vib. Meter
169	Water Brake Forward Vibration Horizontal	Water Brake			Vib. P/U	G.E. Vib. Meter
170	Water Brake Water Flow	Water Brake Inlet			Potter	Digital
171	Vapor Drum Separator Heat. Exch. T/C 47	Vapor Drum			CA T/C	Sanborn
172	Vapor Drum Separator Heat Exch. T/C 48	Vapor Drum			CA T/C	Sanborn
173	Delta -P at Bullet Nose	Item 20 Item 24	3	.0-1.5 psid	X-Ducer	Sanborn + Digital
174	200 "lb Bytrex Temperature	Body of 200" lb Bytrex		150°F	Skin CA T/C	TR #3-14
175	Potassium Turbine * Torque	Glove Box Extension	11	0-25 lb	Load cell	Dial & Digital + Sanborn

* This item will replace Item #88 during tare torque testing only.

TABLE XII

SANBORN LIST

SANBORN NUMBER	CHANNEL NUMBER	ITEM NUMBER	QUANTITY
A	1	86	Speed
"	2	88/175[1]	Water Brake Torque
"	3	106	Forward Bearing Temperature
"	4	98/105*	Pad Bearing Temperature or Rear Ball Bearing Temperature
"	5	108	Ball Bearing Lube Flow
"	6	101	Pad Bearing Lube Flow
"	7	122/123*	Steam Turbine Vibrations Vertical or Horizontal
"	8	124/125*	Potassium Turbine Vibrations Vertical or Horizontal
B	1	139	Potassium Side Seal Pressure (P_8)
"	2	159	Station No. 1 Taylor gage
"	3	3	Turbine Inlet Temperature (Station #1)
"	4	171/ 172	Boiler Separator Heat Exchanger Differential Temp.
"	5	21	Turbine Inlet Pressure (Station #3)
"	6	153	Turbine Differential Pressure (Between Station #s 3 and 7)
"	7	166	Boiler Discharge Vapor Temperature
"	8	160	Station No. 7 Taylor Gage
C	1	82	Main Condenser Flow
"	2	141	Argon Extraction Flow
"	3	81	Condenser Level
"	4	62	Station Number 8 Pressure (Taylor Gauge)
D	1	86	Speed
"	2	142	Boiler Pressure (Taylor Gage)
"	3	152/173*	Bullet Nose Annulus Differential Pressure
"	4	162	Boiler Liquid Level "J" Tube
"	5	164/165*	VPL-11 Position or Water Brake Inlet Valve Position
"	6	155	Boiler Feed Flow
"	7	154	Boiler Feed Temperature
"	8	47	Turbine Exit Temperature (Station #7)

* Switch must be provided to read either value on Sanborn Recorder.

[1] Item #175 will be used during tare torque testing only and will replace item #88.

TABLE XIII

TURBINE INSTRUMENTATION CHANGES

Item No.	Quantity	Digital	Sanborn	Remarks
116	Brake inlet temperature	Yes	No	Digital reading permits check on water brake torque
117	Brake outlet temperature	Yes	No	
120	Brake water flow	Yes	No	
128	K seal inlet temperature	Yes	No	Digital reading permits check on hydrodynamic seal energy
129	K seal outlet temperature	Yes	No	
132	K seal flow	Yes	No	
152	Bullet nose differential pressure	Yes	Yes	Digital: primary from measurement; Sanborn velocity transients
153	Turbine differential pressure	Yes	Yes	Useful in setting turbine pressure ratio; gives turbine pressure drop transient during instabilities
154	Boiler feed temperature	No	Yes	Shows connection of the quantities to instabilities
155	Boiler feed flow	No	Yes	
156	B Heater calorimeter power	Yes	No	Permits reduction of exit calorimeter measurements with other performance data on digital
157	A Heater calorimeter power	Yes	No	
158	Compensating heater power	Yes	No	Heat loss or gain can be analyzed with other digital data
159	Station No. 1 Taylor gage	Yes	Yes	Yields turbine pressure ratio with efflux system inoperative
160	Station No. 7 Taylor gage	Yes	Yes	
161	Shaft radial movement	No	No	Information on mechanical operation
162	Boiler "J" tube liquid level	No	Yes	Permits transients to be monitored during instability
164	Throttle valve position	No	Yes	Permits determining whether these valve positions effect stability
165	Water brake valve position	No	Yes	
166	Boiler discharge temperature	Yes	Yes	Permanent record of amount of main vapor valve throttling
167	Station No. 3 temperature	Yes	No	Permits Station No. 3 static pressures to be compared to vapor pressure
102	K turbine lube outlet temperature	Yes	No	Permits connecting tare torque for lube temperature
103	K turbine lube inlet temperature	Yes	No	

TABLE XIV

ACCURACY OF TURBINE EFFICIENCY INSTRUMENTATION

ITEM NO.	QUANTITY	STA. NO.	ESTIMATED ABSOLUTE SYSTEM ACCURACY	UNITS
18	Total Pressure	3	$\pm$ 1.0	psia
19	Total Pressure	3	"	"
20	Total Pressure	3	"	"
21	Total Pressure	3	"	"
152	Differential Pressure	3	$\pm$ 0.015	psid
173	Differential Pressure	3	"	"
38	Total Pressure	7	$\pm$ 1.0	psia
39	Total Pressure	7	"	"
40	Total Pressure	7	"	"
41	Total Pressure	7	"	"
14	Calorimeter Pressure	1	"	"
90	RTD CATS		$\pm$ 0.02 ($\pm$ 2)	MV ($\pm$ 2°F)
13	Calorimeter Temperature	1	$\pm$ 5	°F
86	Speed	11	$\pm$ 44	Rpm
87	Steam Turbine Torque	11	$\pm$ 2	in. lbs.
88	K Turbine Torque (100# Load Cell)	11	$\pm$ 3.75	in. lbs.
46	Vaporization Temperature	7	7	°F
47	Vaporization Temperature	7	"	"
48	Vaporization Temperature	7	"	"
49	Vaporization Temperature	7	"	"
50	Vaporization Temperature	7	"	"
51	Vaporization Temperature	7	"	"
167	Vaporization Temperature	3	"	"
175	K Turbine Torque (25# Load Cell)	11	1.0	in. lbs.

TABLE XV

INSTRUMENTATION ACCURACY

QUANTITY	ESTIMATED ACCURACY	UNITS
Pressure, efflux	± 1.0	psia
Pressure, efflux, differential	± 0.3	psid
Pressure, Taylor	± 4.0	% F.S.
Temperature, digital	± 7.0	°F
Temperature, Sanborn	± 1	% F.S.
Temperature, multipoint	± 1	% F.S.
Flow, EMFM	± 5	% Rdg
plus	± 0.1	M.V.
Pressure, differential, lube flow	± 2.0	in. H_2O
Flow, water brake	± 2.0	gpm
Power, calorimeter	± 0.05	KW

TABLE XVI
DUMP TANK POTASSIUM ANALYSIS

Analysis Date	Time and Temperature for Hot Gettering or Other Pertinent History	Impurities in Parts Per Million	
		Oxygen	Carbon
5/7/64	Oil contamination of the dump tank potassium	Not Detmd	88
5/27/64	After the potassium was hot trapped with zirconium at 1100°F to 1150°F for 100 hours in the stainless steel dump tank	18	59
6/24/64	After additional hot trapping at 1175°F for 250 hours	17.5	43
7/23/64	Operation of the facility was expected to flush any oil remaining in the condenser and associated components without a serious increase in carbon and oxygen content. Sample taken after turbine operation	42	40
9/26/64	Sample taken after hot trapping	5.4	200
10/1/64	During resumption of turbine testing, a minor instrumentation leak necessitated a shutdown	7.5	36
10/1/64	Potassium was flushed through the system to collect ungettered oxygen	7.6	52
10/5/64	During resumption of turbine testing, a minor instrumentation leak necessitated a facility shutdown	13.1	199
10/13/64	Turbine testing was renewed on 10-8-64. Facility shutdown was necessitated on 10-13-64 because of a boiler leak.	44.8	177
12/22/64	Potassium hot trapped at 1100°F for 1,000 hours during facility modifications	7.2	98

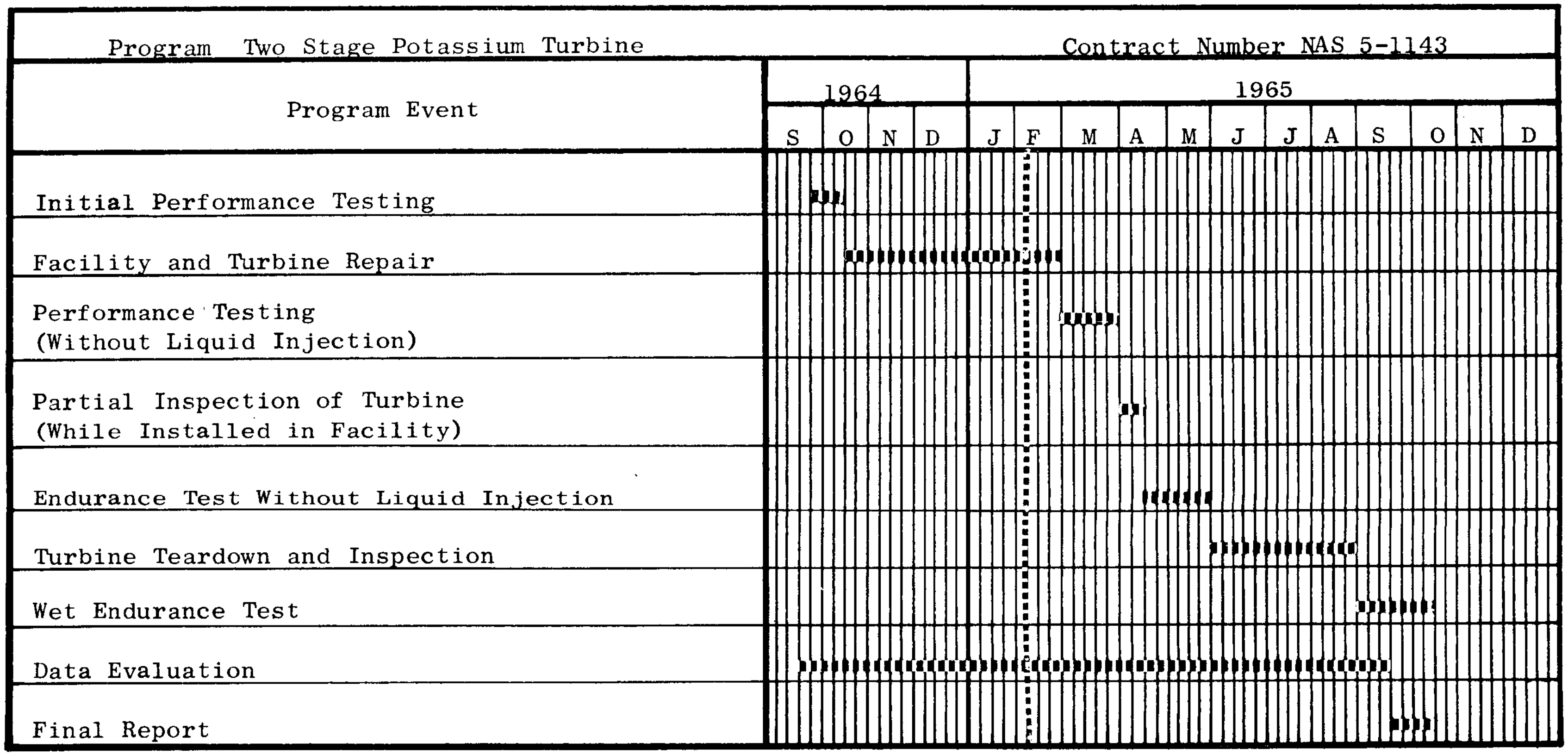


Figure 1. Program Schedule

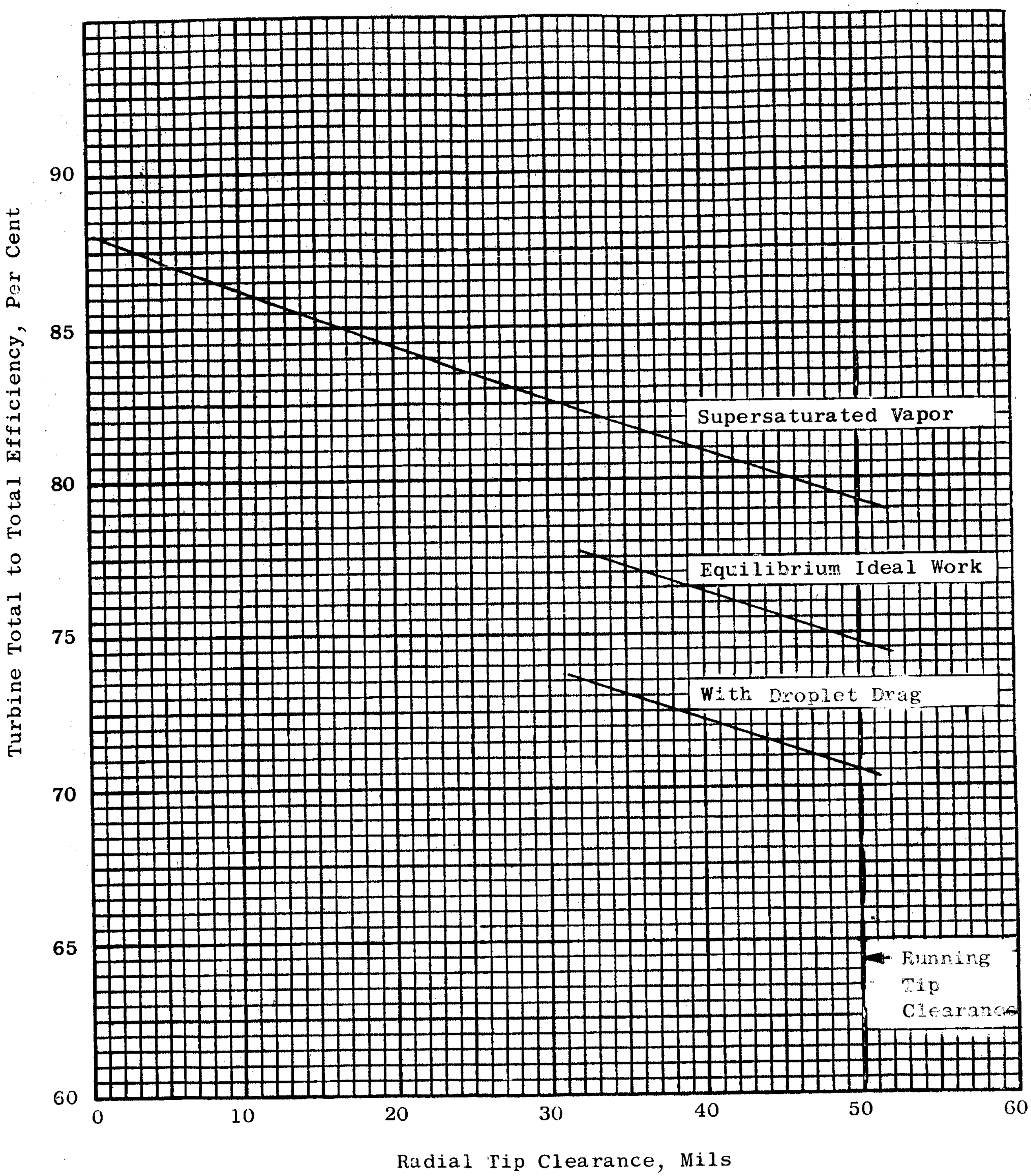


Figure 2 Effect of Tip Clearance and Other Losses on Design Point Turbine Total To Total Efficiency.

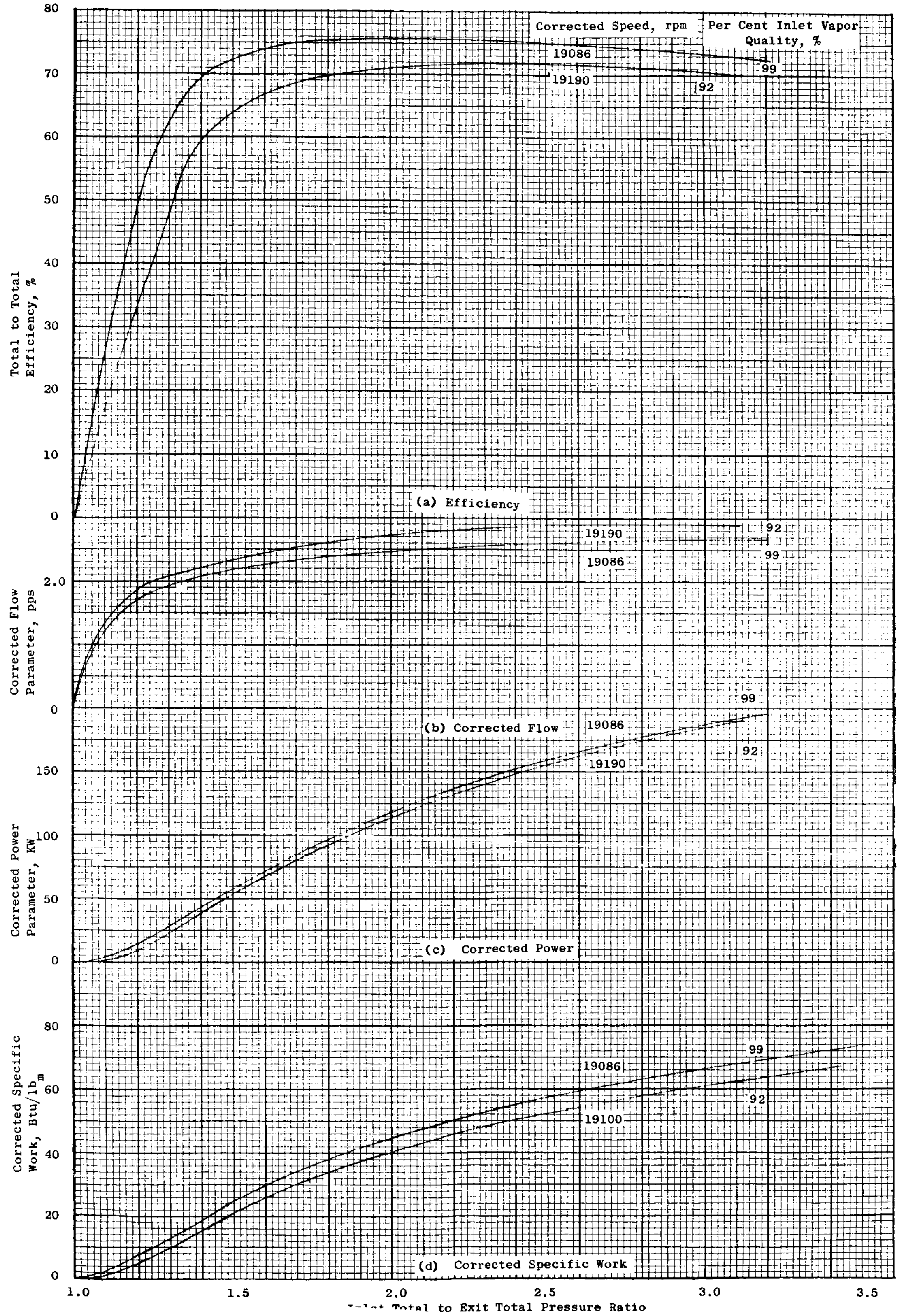


Figure 3. Turbine Predicted Performance Parameter Variation For 1600°F, 99 and 92 Per Cent Vapor Quality

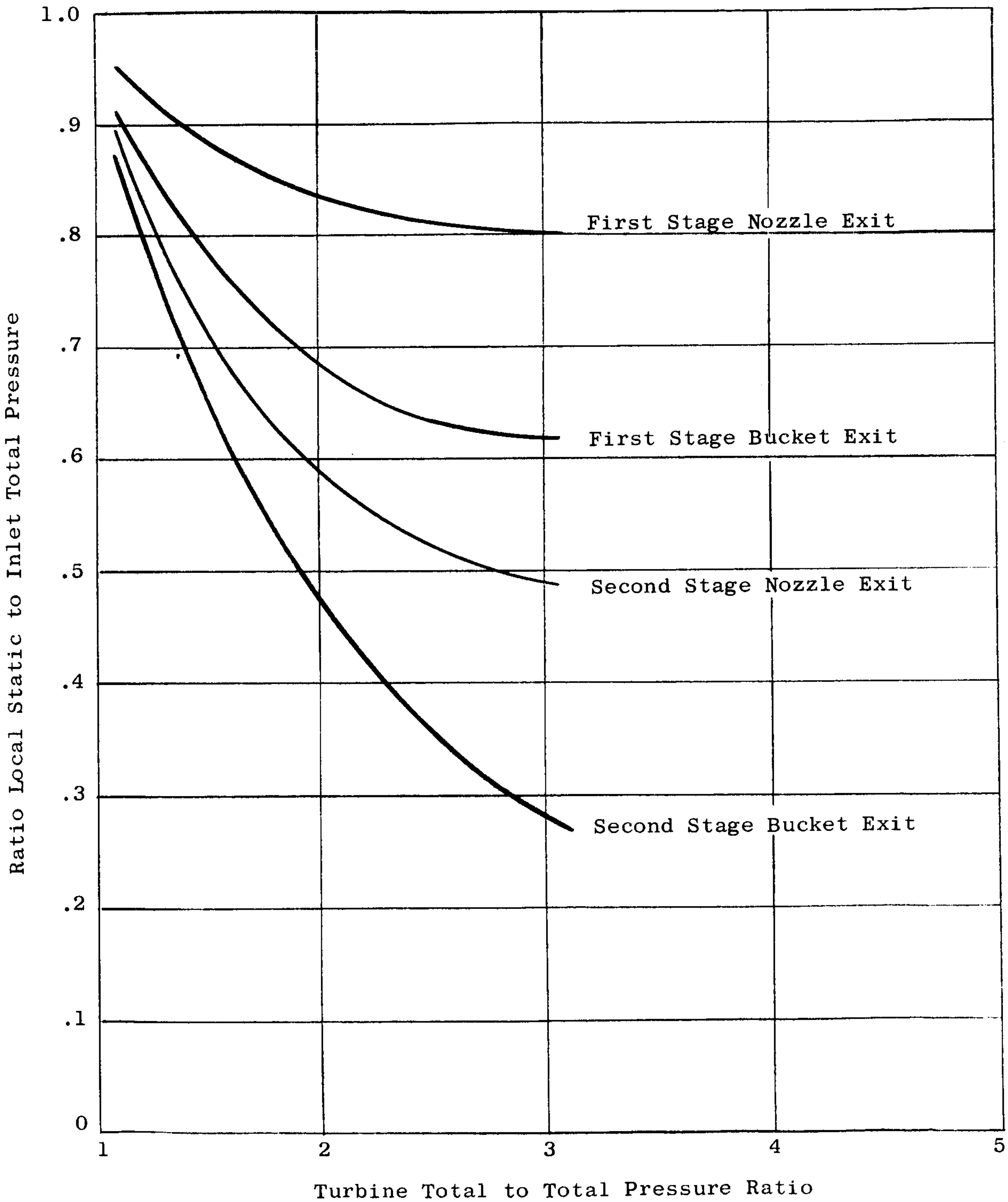


Figure 4. Estimated Variation of Static Pressures Downstream of Blade Rows With Turbine Pressure Ratio. Inlet Temperature, 1600°F, Inlet Vapor Quality, 92 Per Cent, Rotative Speed, 19,200 rpm.

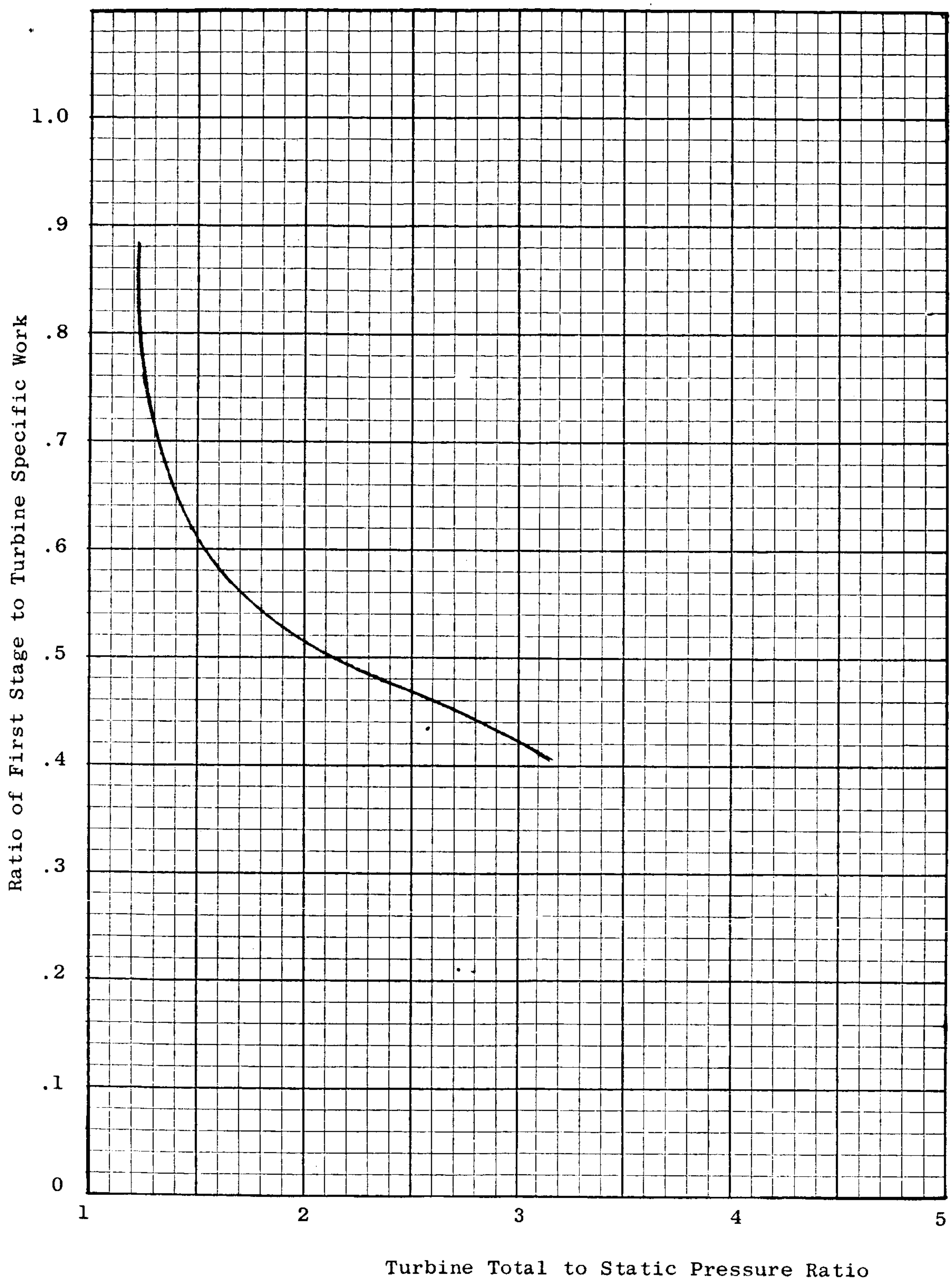


Figure 5 Estimated Variation in Work Division Between Turbine Stages With Turbine Pressure Ratio. Inlet Temperature, 1600°F, Inlet Vapor Quality, 92 Per Cent, Rotative Speed, 19,200 rpm.

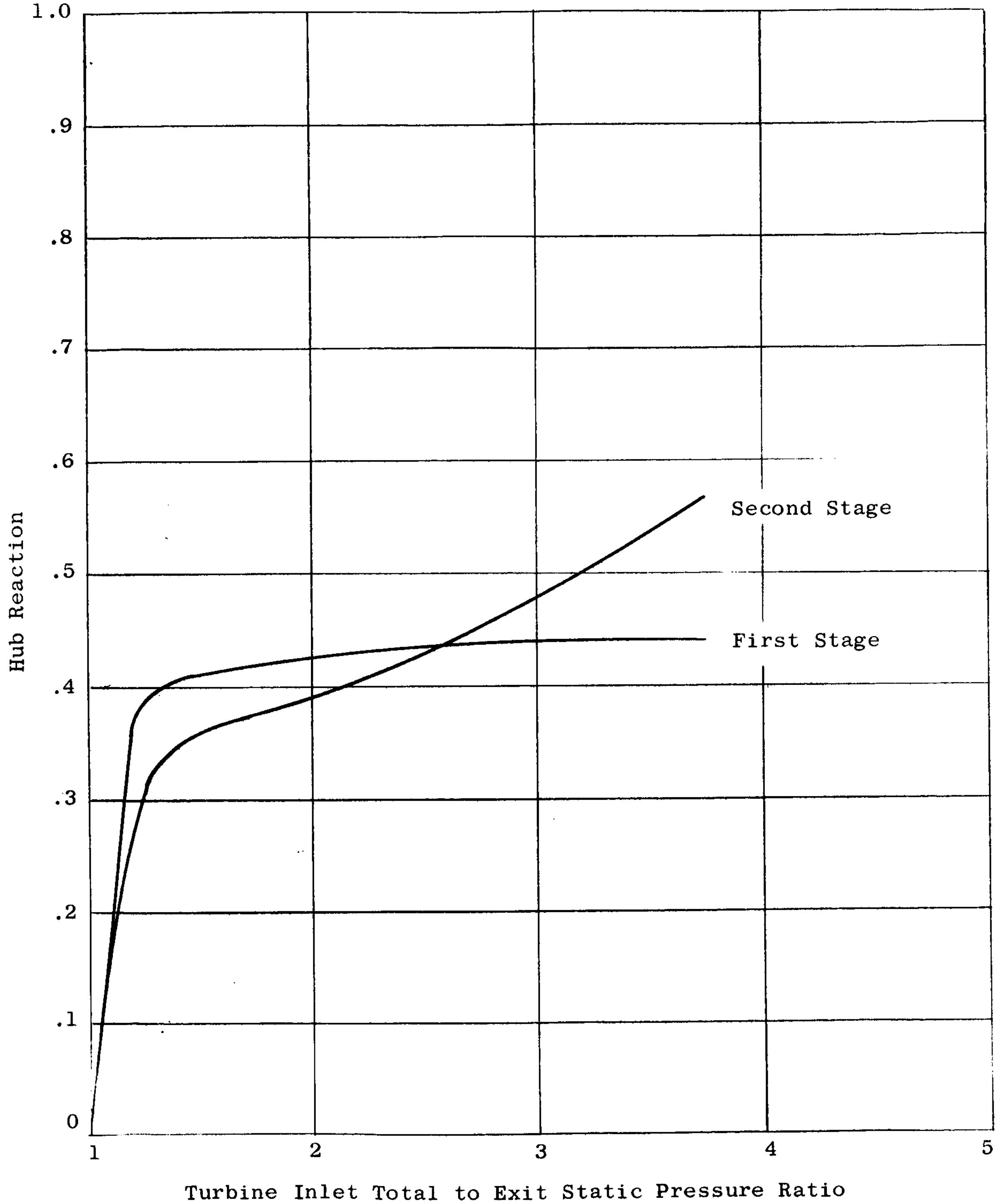


Figure 6. Estimated Variation in Stage Reaction With Turbine Pressure Ratio. Inlet Temperature, 1600°F, Inlet Vapor Quality, 92 Per Cent, Rotative Speed, 19,200 rpm.

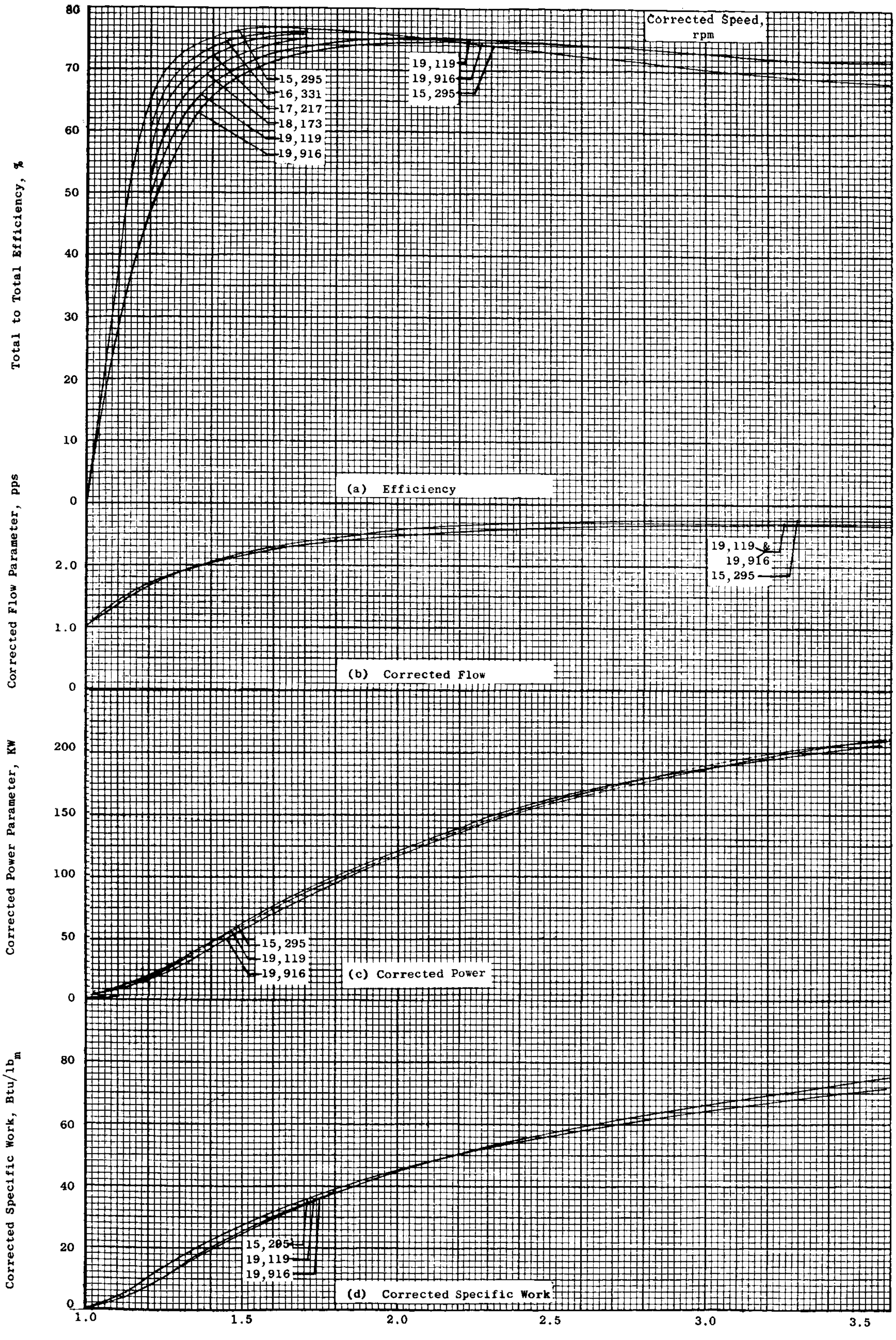


Figure 7. Turbine Predicted Performance Parameter Variation for 1550°F, 99 Per Cent Vapor Quality Inlet Conditions.

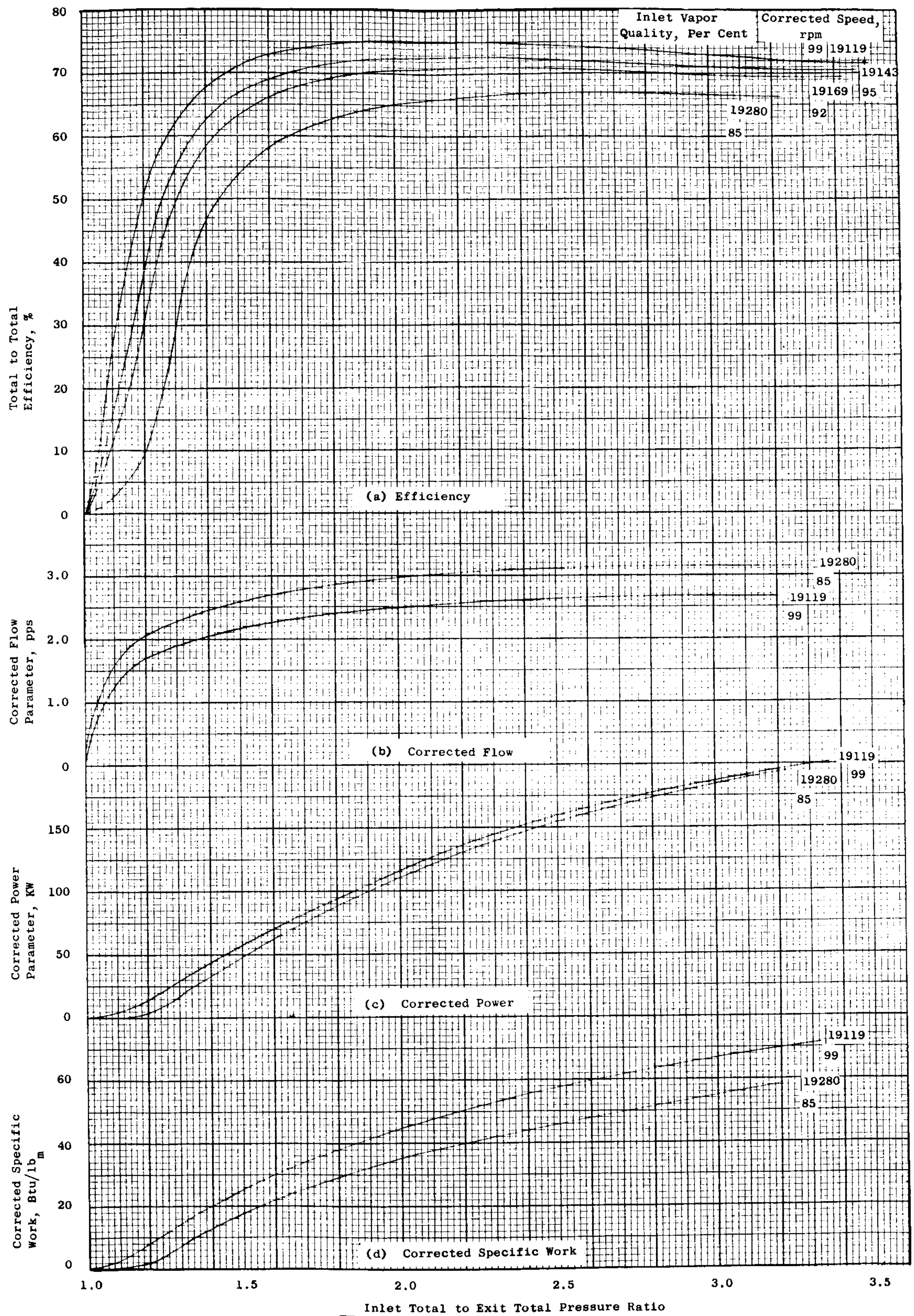


Figure 8. Turbine Predicted Performance Parameter Variation for 1550°F, 85 to 99 Per Cent Vapor Quality Inlet Conditions.

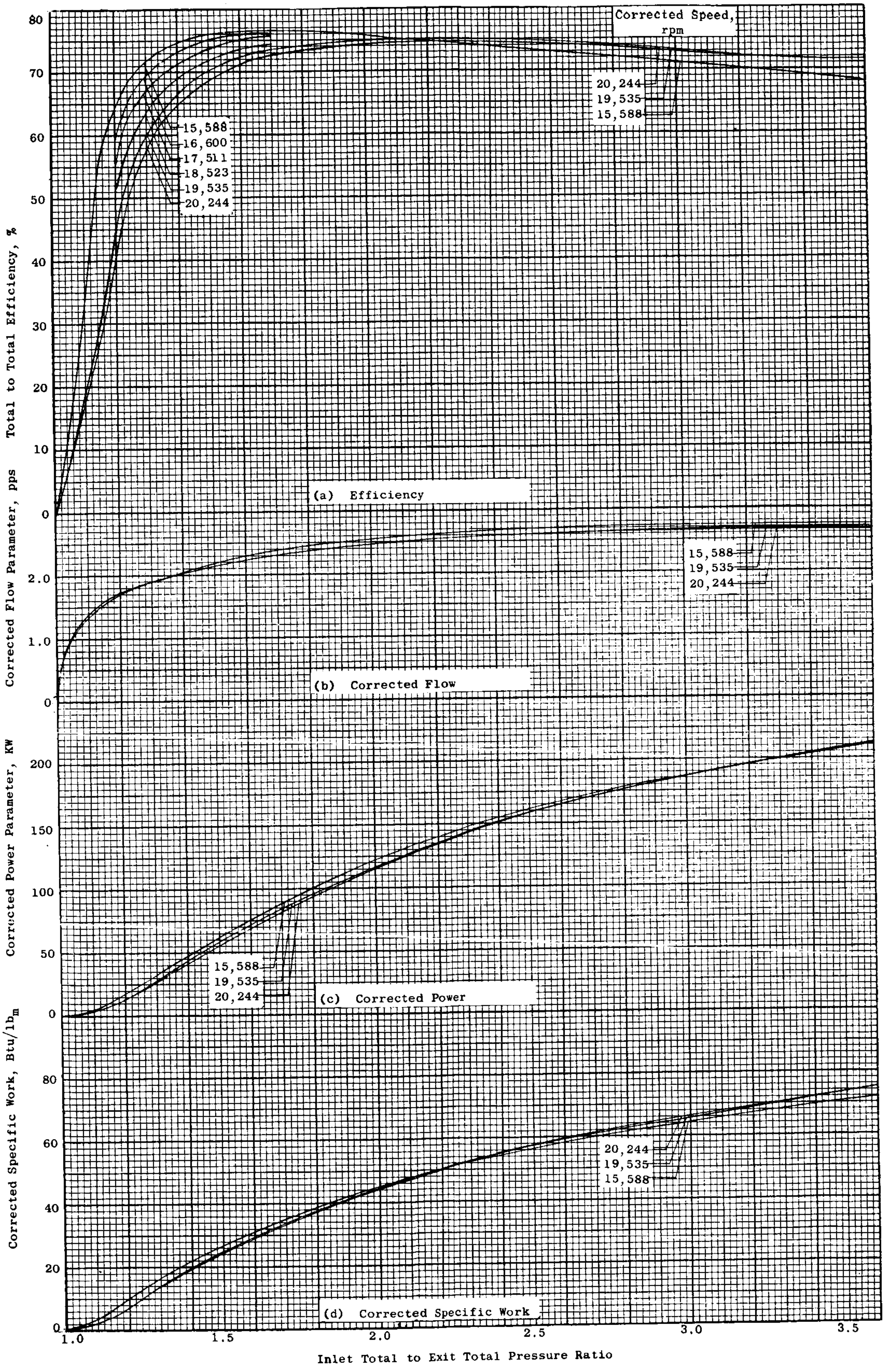


Figure 9 Turbine Predicted Performance Parameter Variation for 1450°F, 99 Per Cent Vapor Quality Inlet Conditions

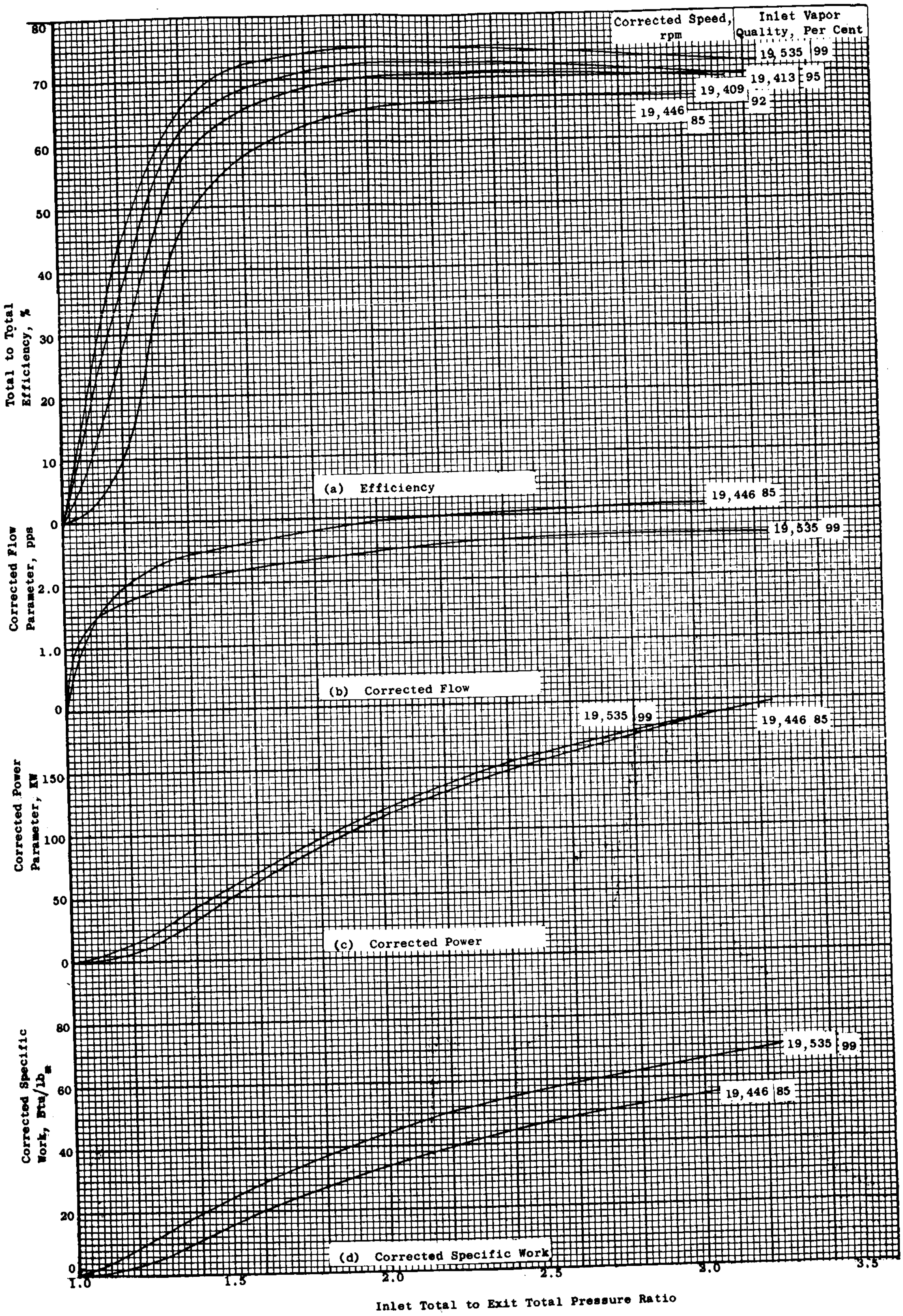


Figure 10 Turbine Predicted Performance Parameter Variation for $1450^{O}F$, 85 to 99 Per Cent Vapor Quality Inlet Conditions

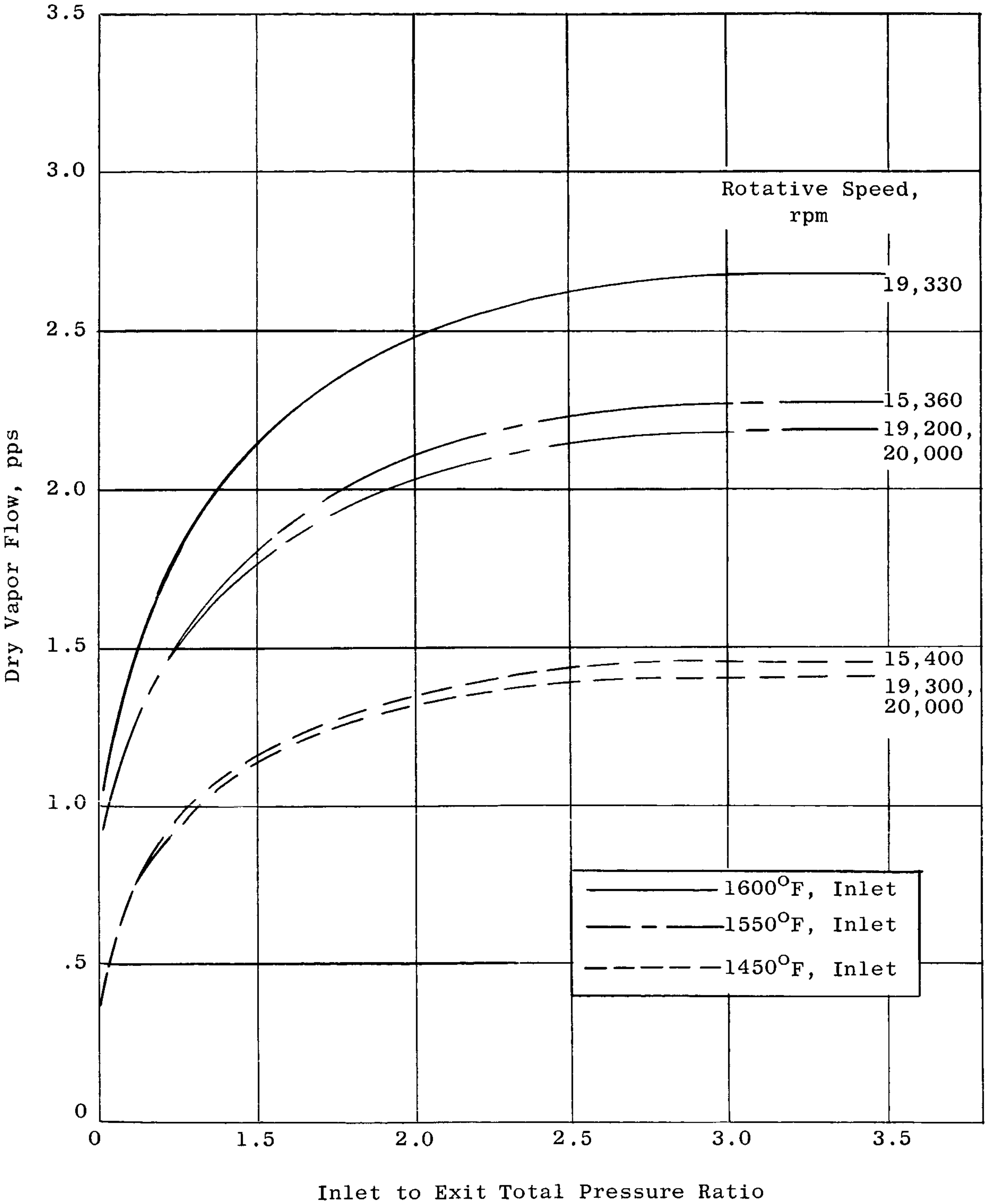


Figure 11. Predicted Turbine Dry Vapor Flow Variation For 1600, 1550 and 1450^{O}F and 99 Per Cent Vapor Quality Inlet Conditions.

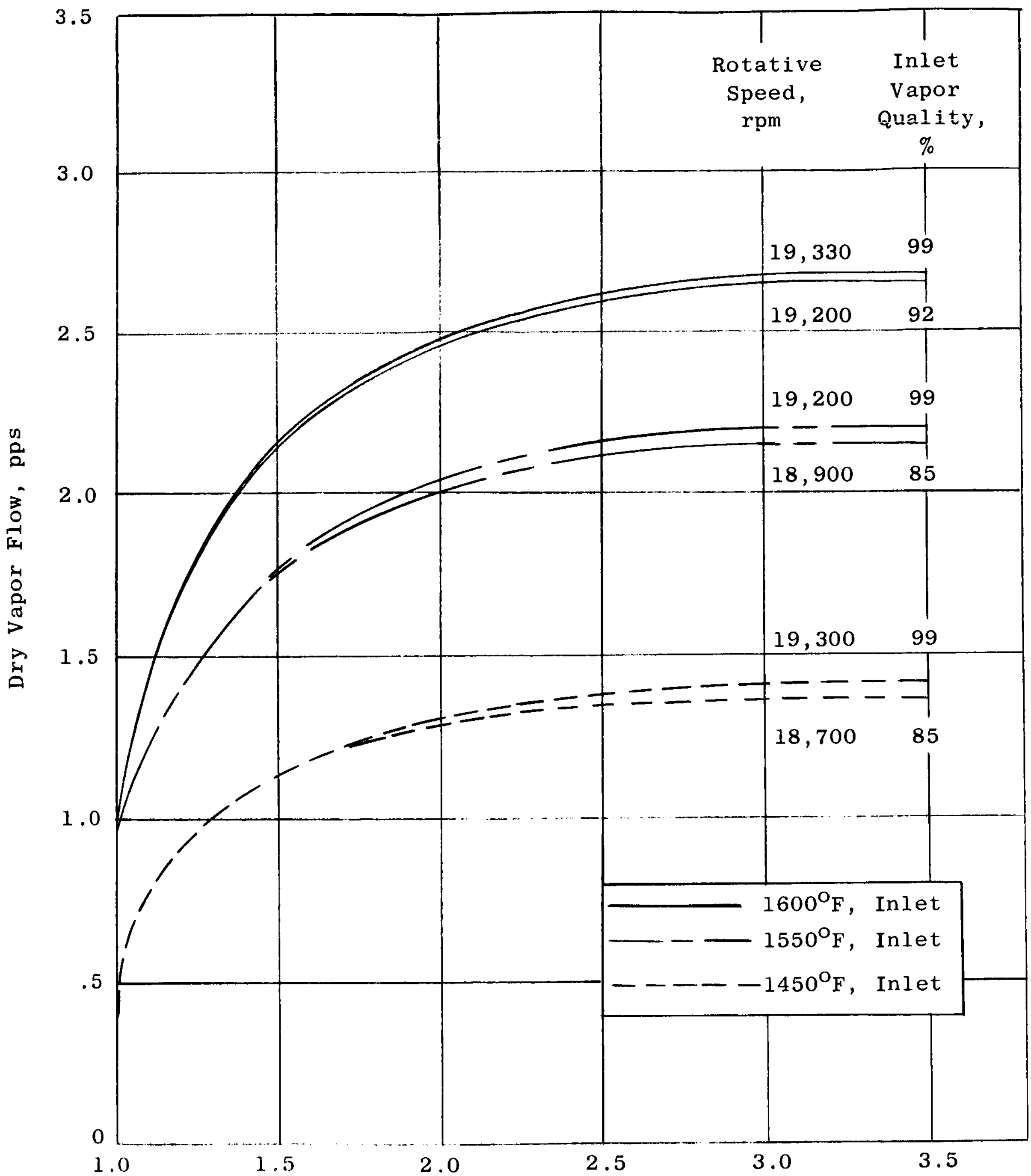


Figure 12. Predicted Turbine Dry Vapor Flow Variation For 1600, 1550 and 1450°F and 85 to 99 Per Cent Vapor Quality Inlet Conditions.

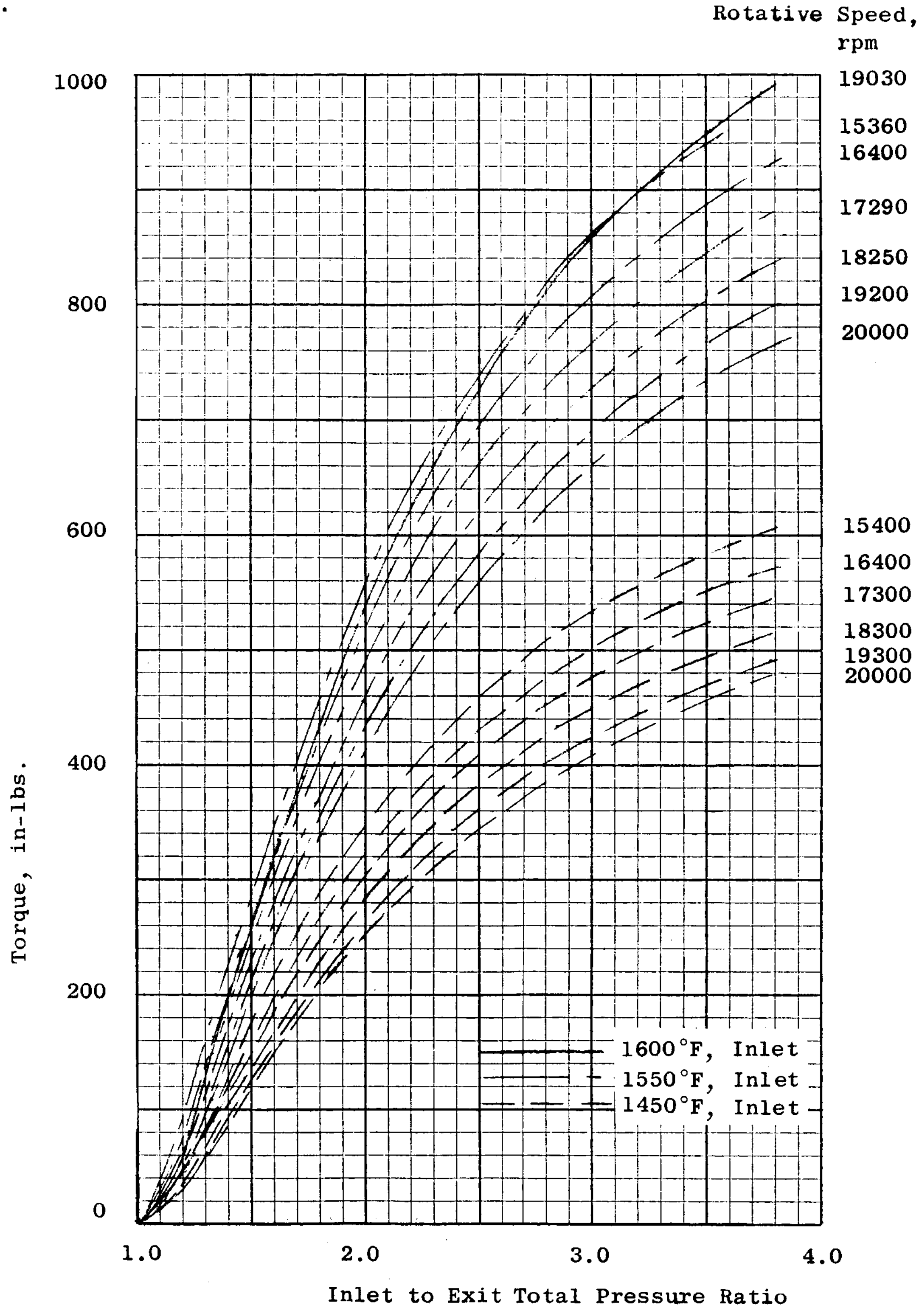


Figure 13. Predicted Turbine Net Shaft Torque Variation for 1600, 1550 and 1450°F and 99 Per Cent Vapor Quality Inlet Conditions.

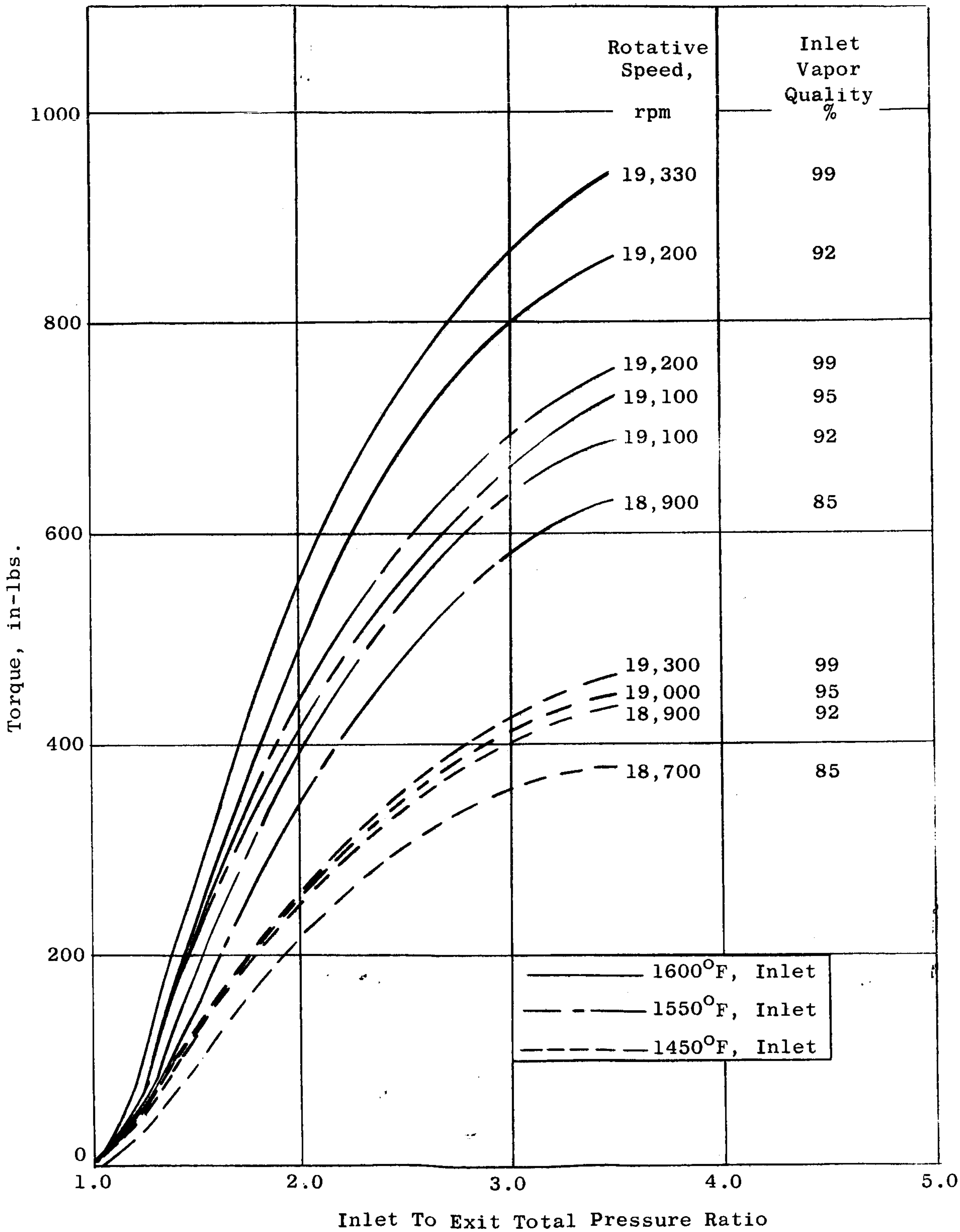


Figure 14. Predicted Net Shaft Torque Variation for 1600, 1550, and 1450°F and 85 to 99 Per Cent Vapor Quality Inlet Conditions.

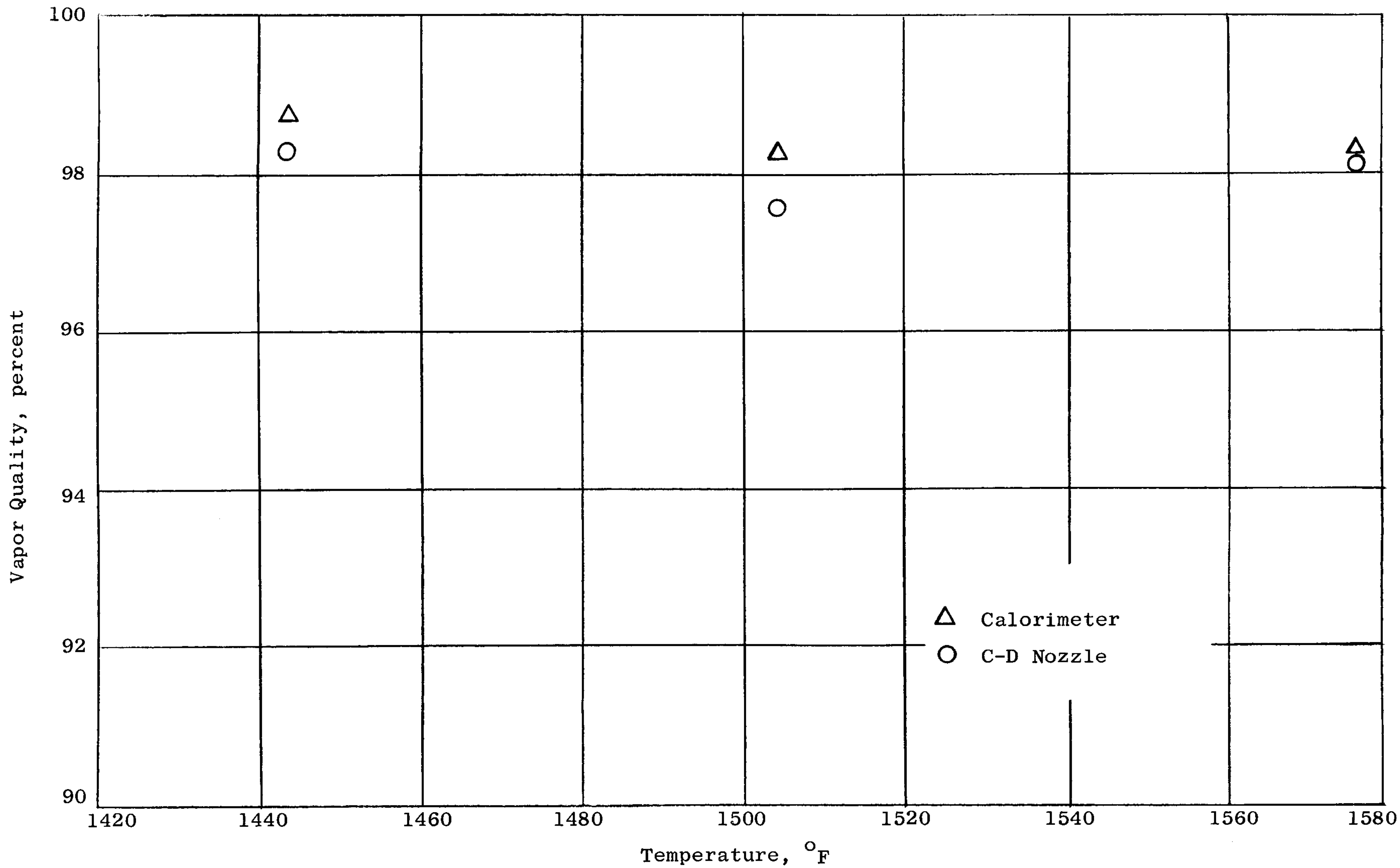


Figure 15. Comparison of Quality from Throttling Calorimeter and C-D Nozzle.

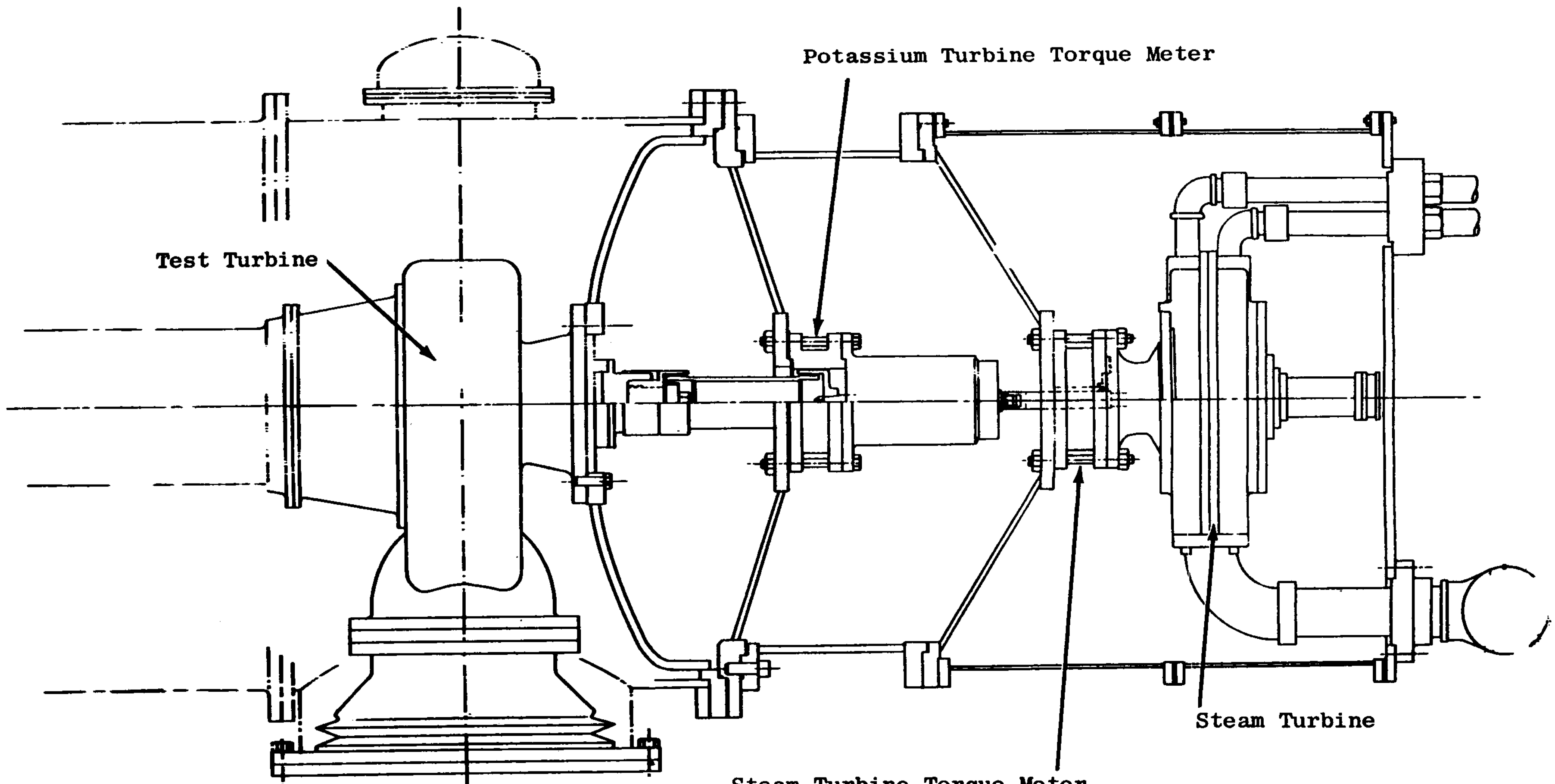


Figure 16 Installation Drawing

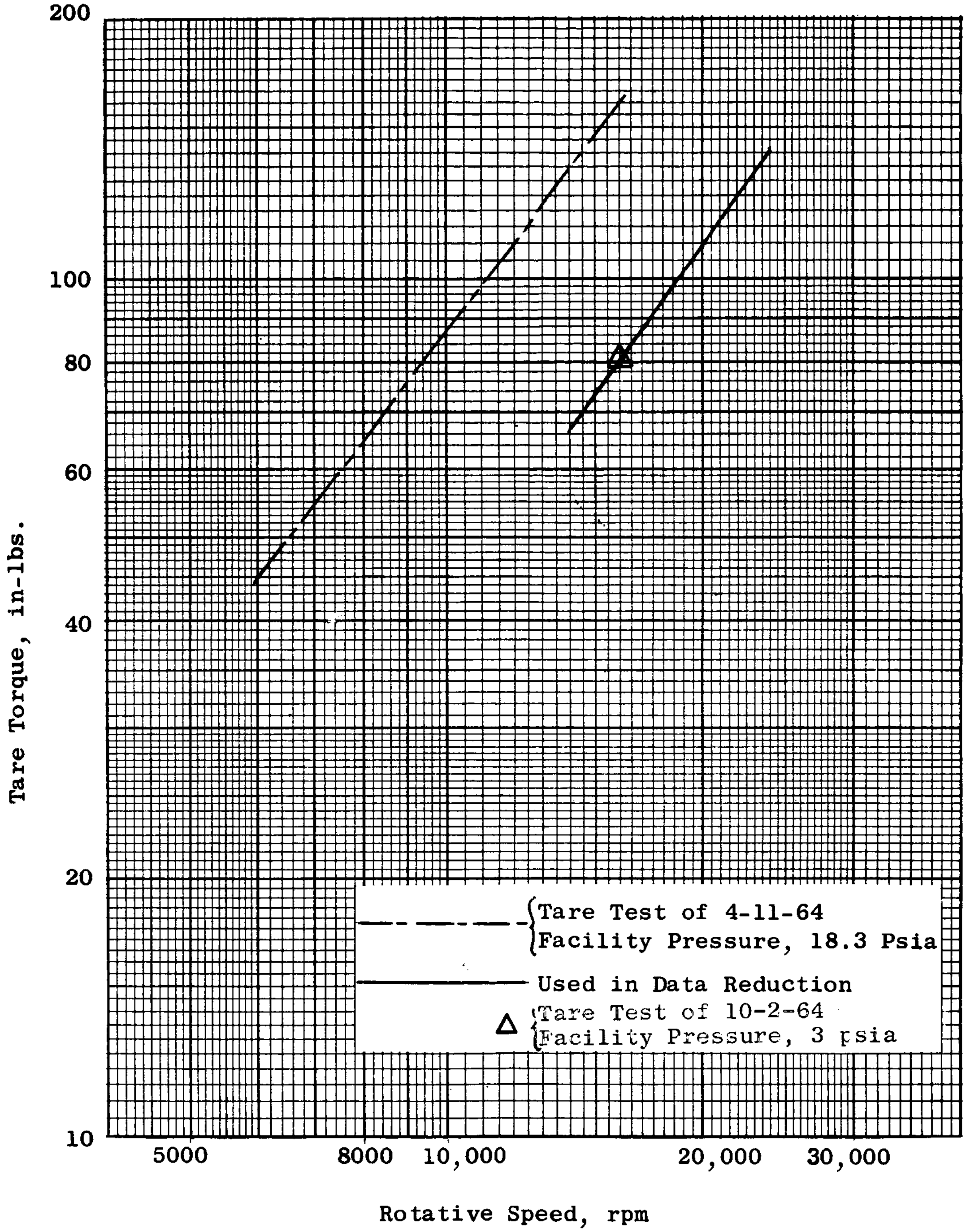


Figure 17 Estimated Tare Torque Used in Data Evaluation.

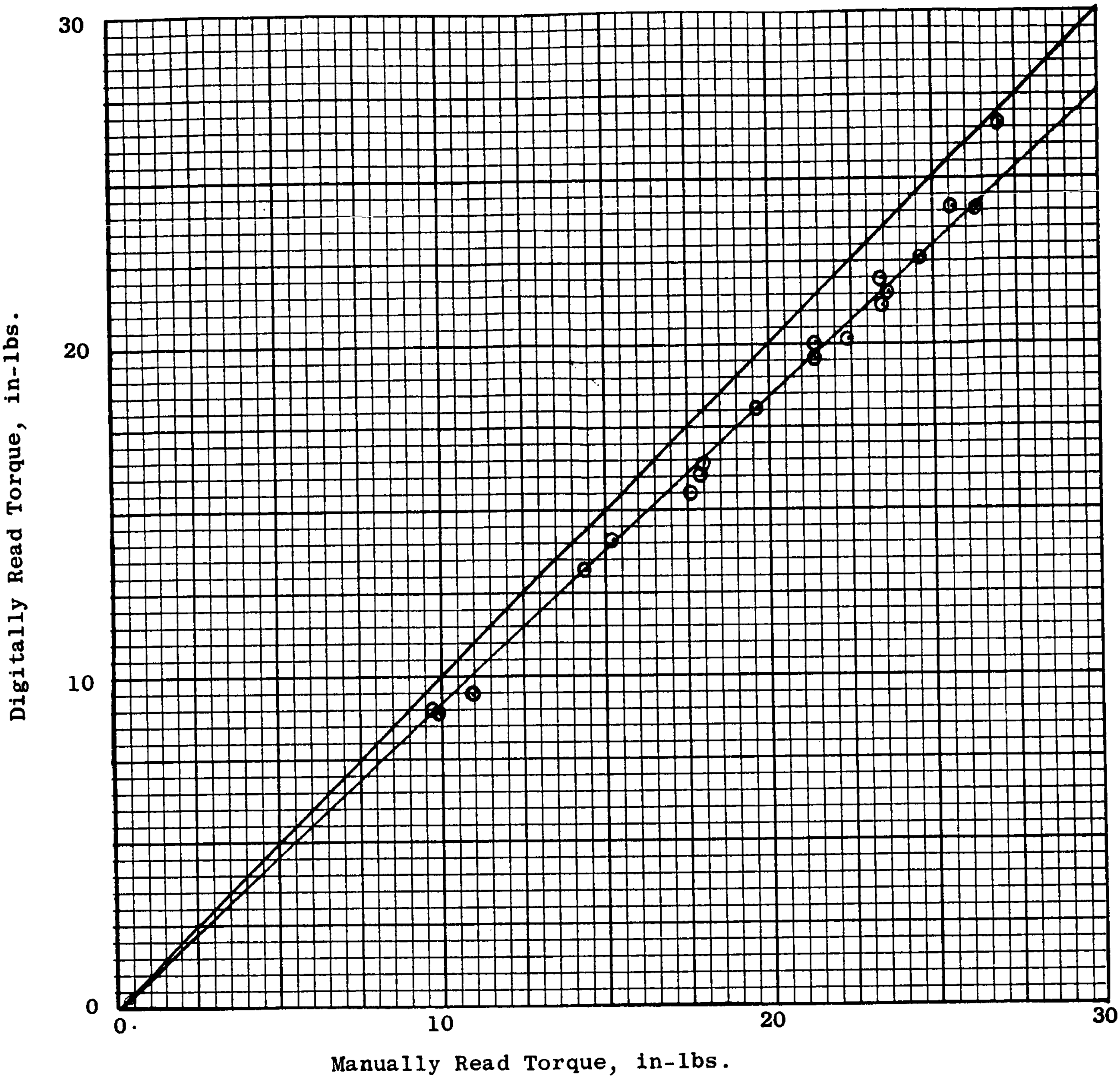


Figure 1[illegible]. Comparison of Digitally and Manually Read Torque Values. Test Date, December 14, 1964.

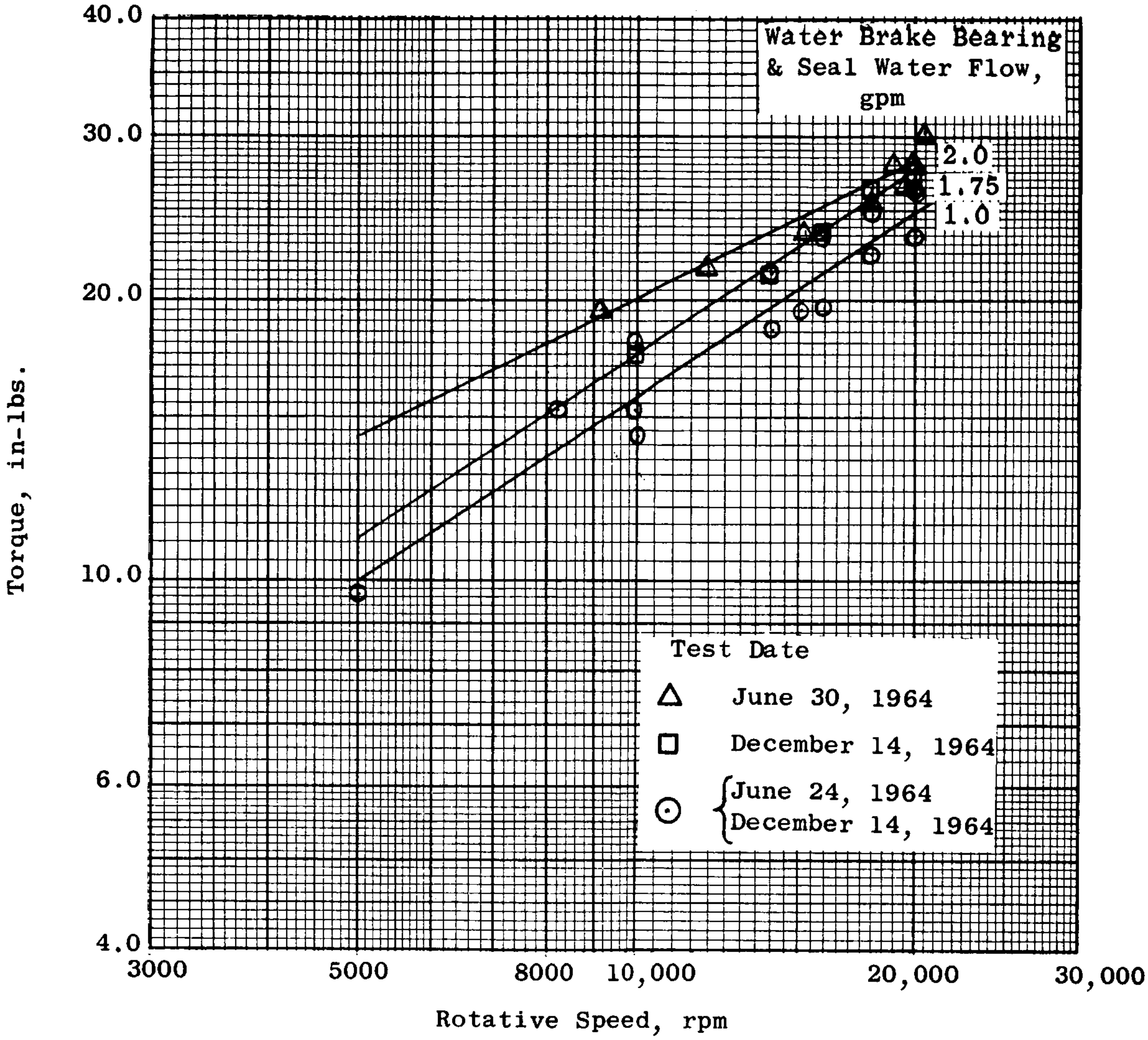


Figure 19 Variation of Water Brake Torque With Rotative Speed and Bearing Coolant Water Flow. Test Dates, June 24, 1964, June 30, 1964 and December 14, 1964.

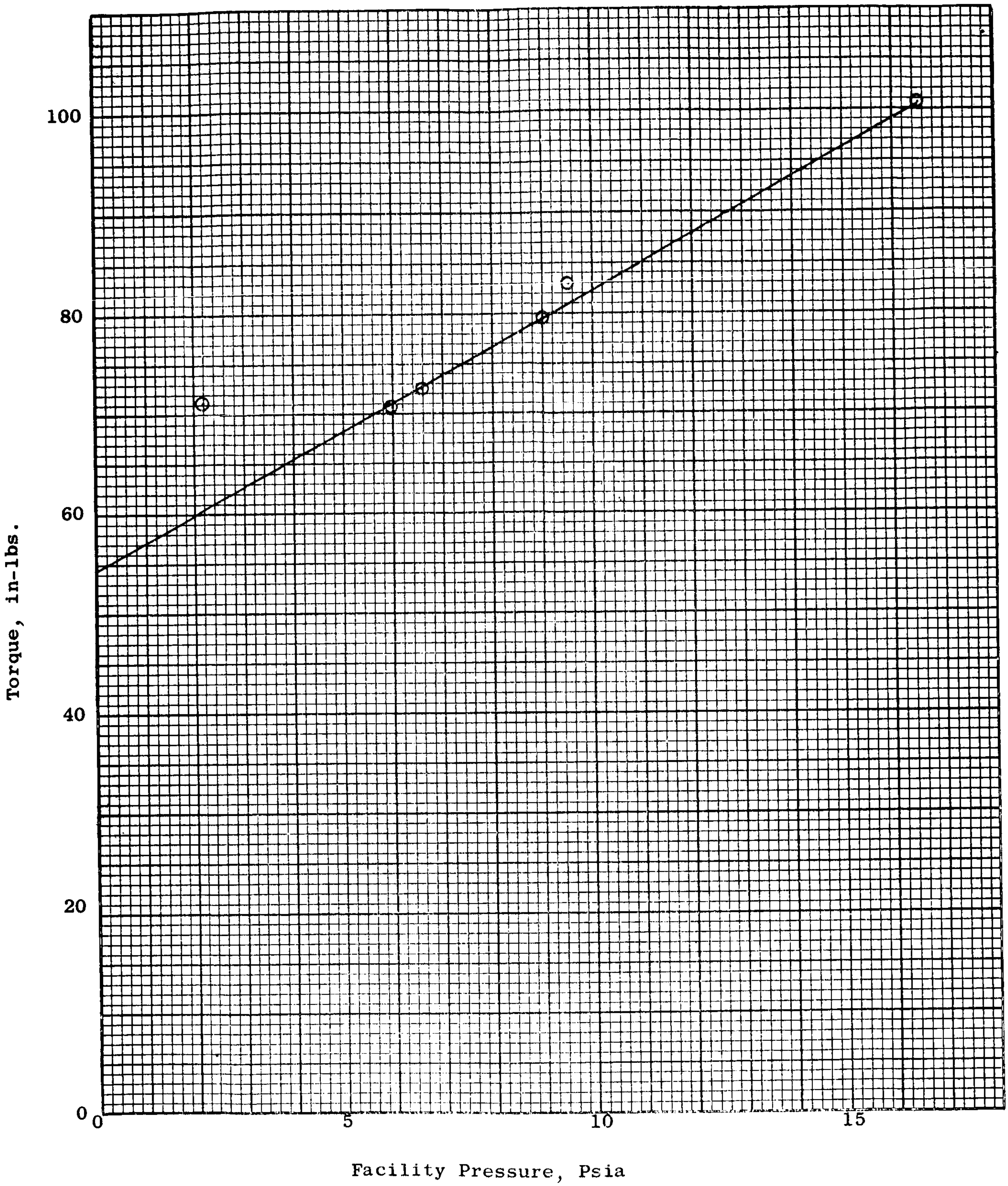


Figure 29 Variation of Turbine Bearing Torque Plus Blade Windage Torque With Facility Pressure. "Rotative Speed, 14,700 rpm". Test Date, April 11, 1964.

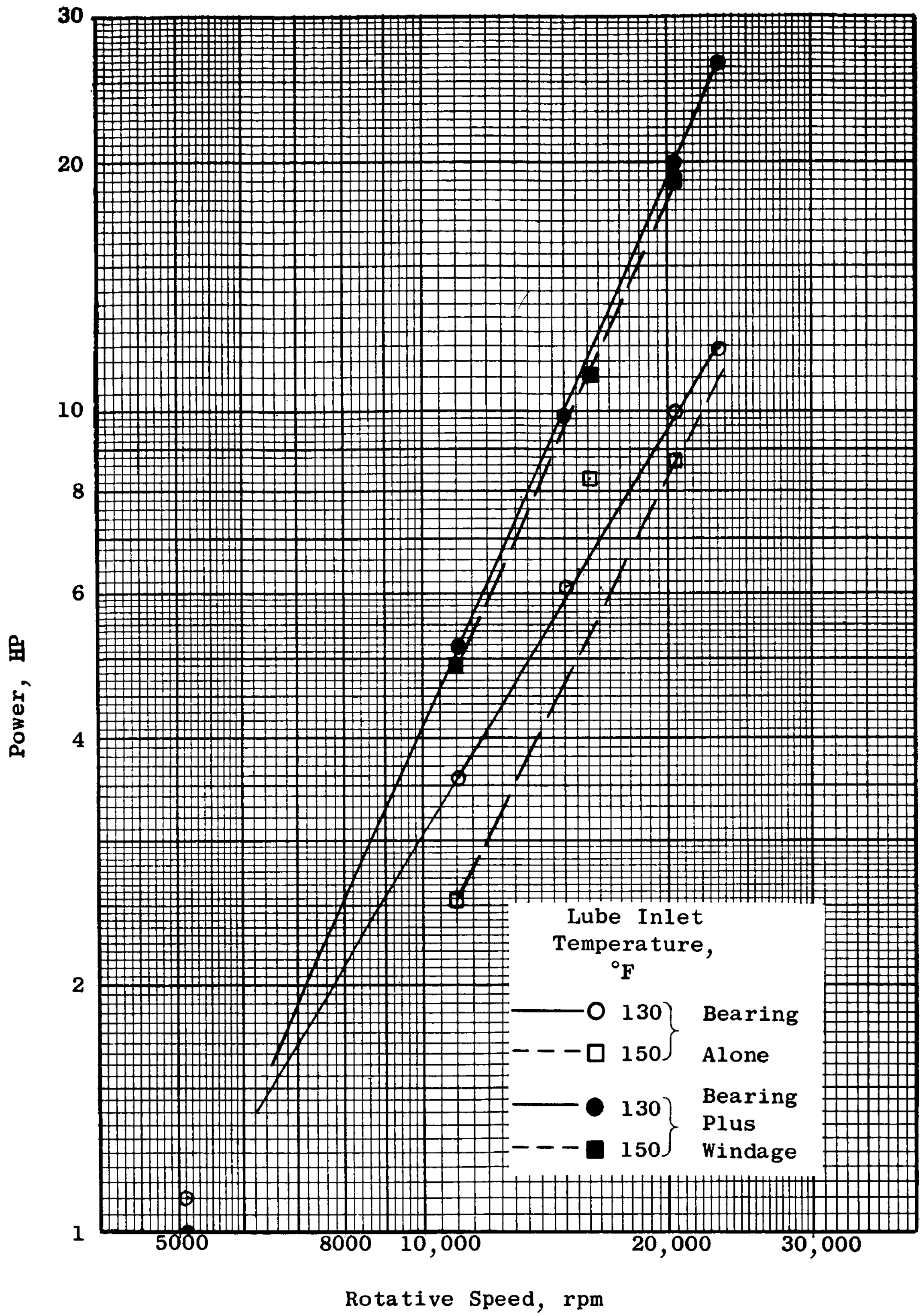


Figure 21a Variation of Turbine Bearing Power and Disk Windage in Normal Air Plus Turbine Bearing Power Versus Rotative Speed for a Pad Bearing Lube Flow of 2.25 gpm. Test Date, August 17, 1963.

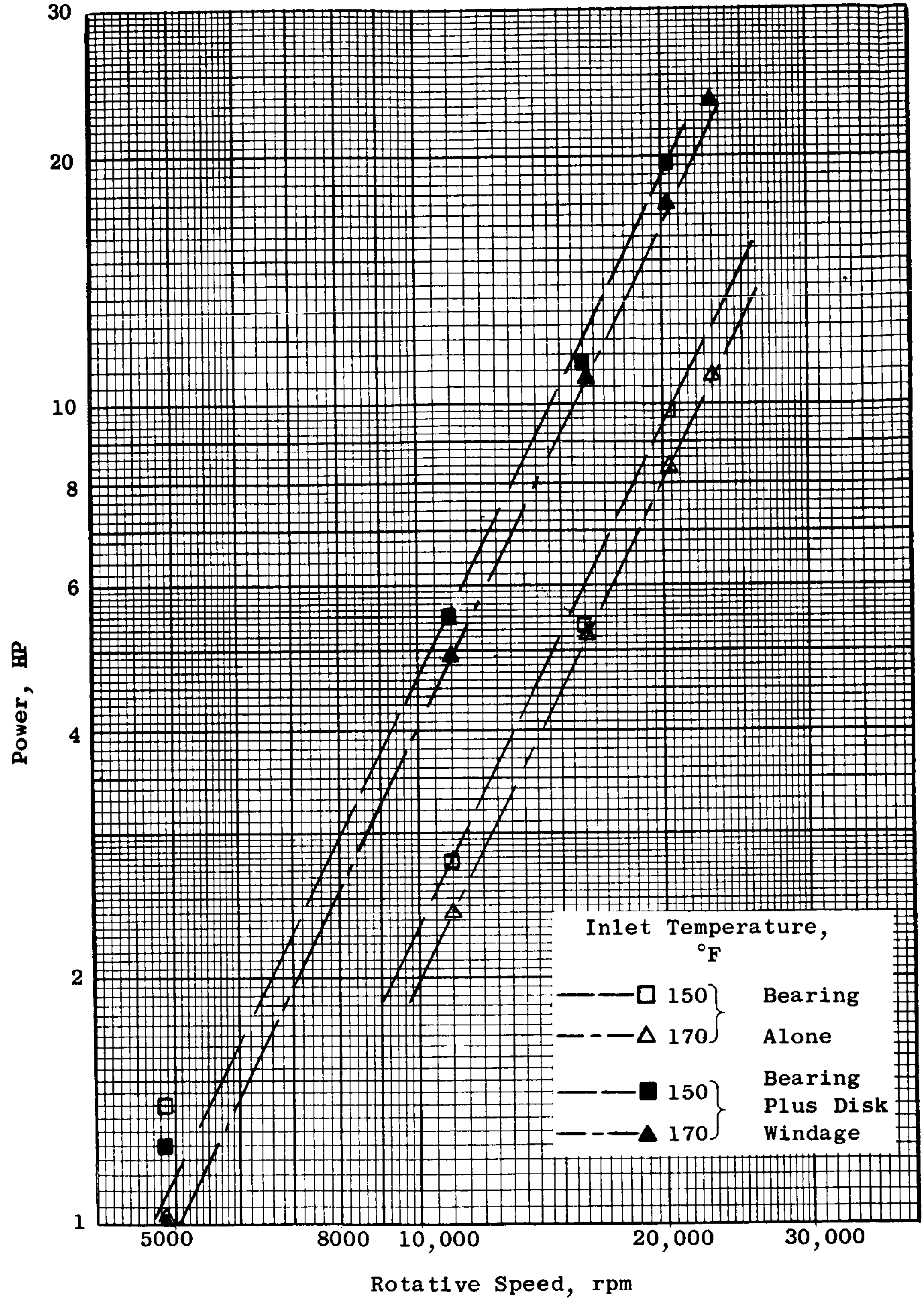


Figure 21b Variation of Turbine Bearing Power and Disk Windage in Normal Air Plus Turbine Bearing Power Versus Rotative Speed for a Pad Bearing Lube Flow of 4.2 gpm. Test Date, August 17, 1963.

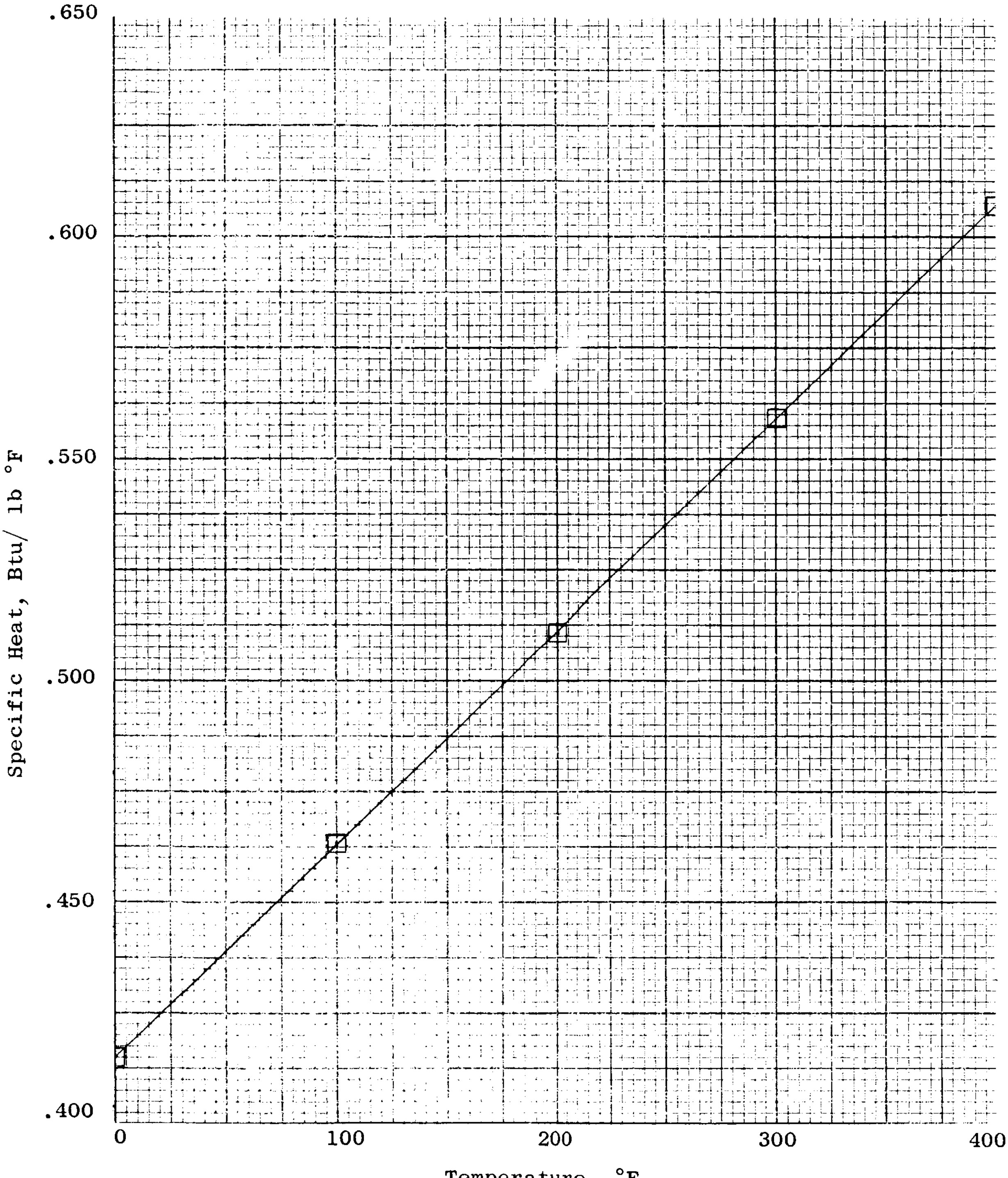


Figure 22 Variation of Turbine Oil Specific Heat With Temperature

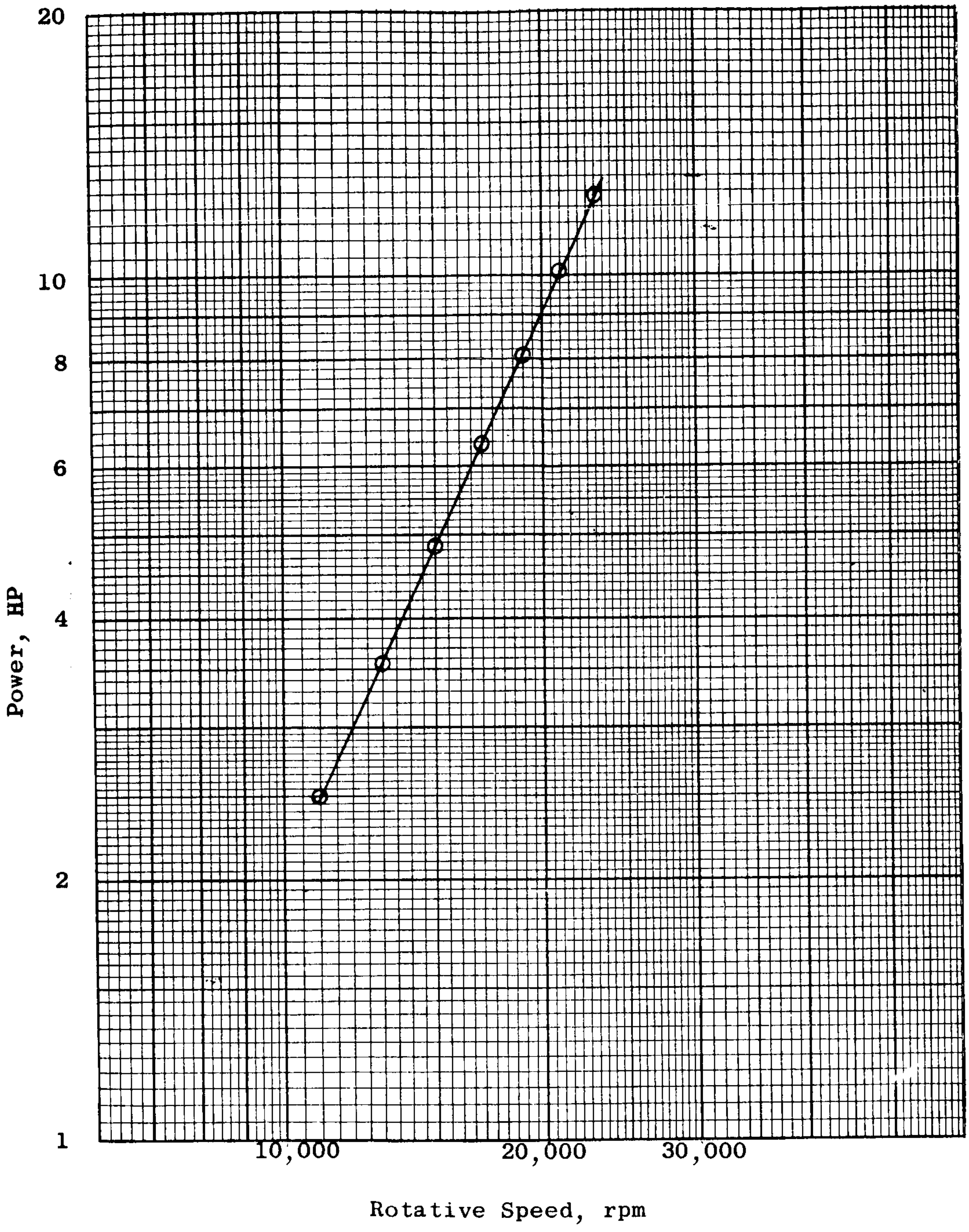


Figure 23 Average Variation of Turbine Disk Windage With Speed in Normal Air. Test Date, August 17, 1963.

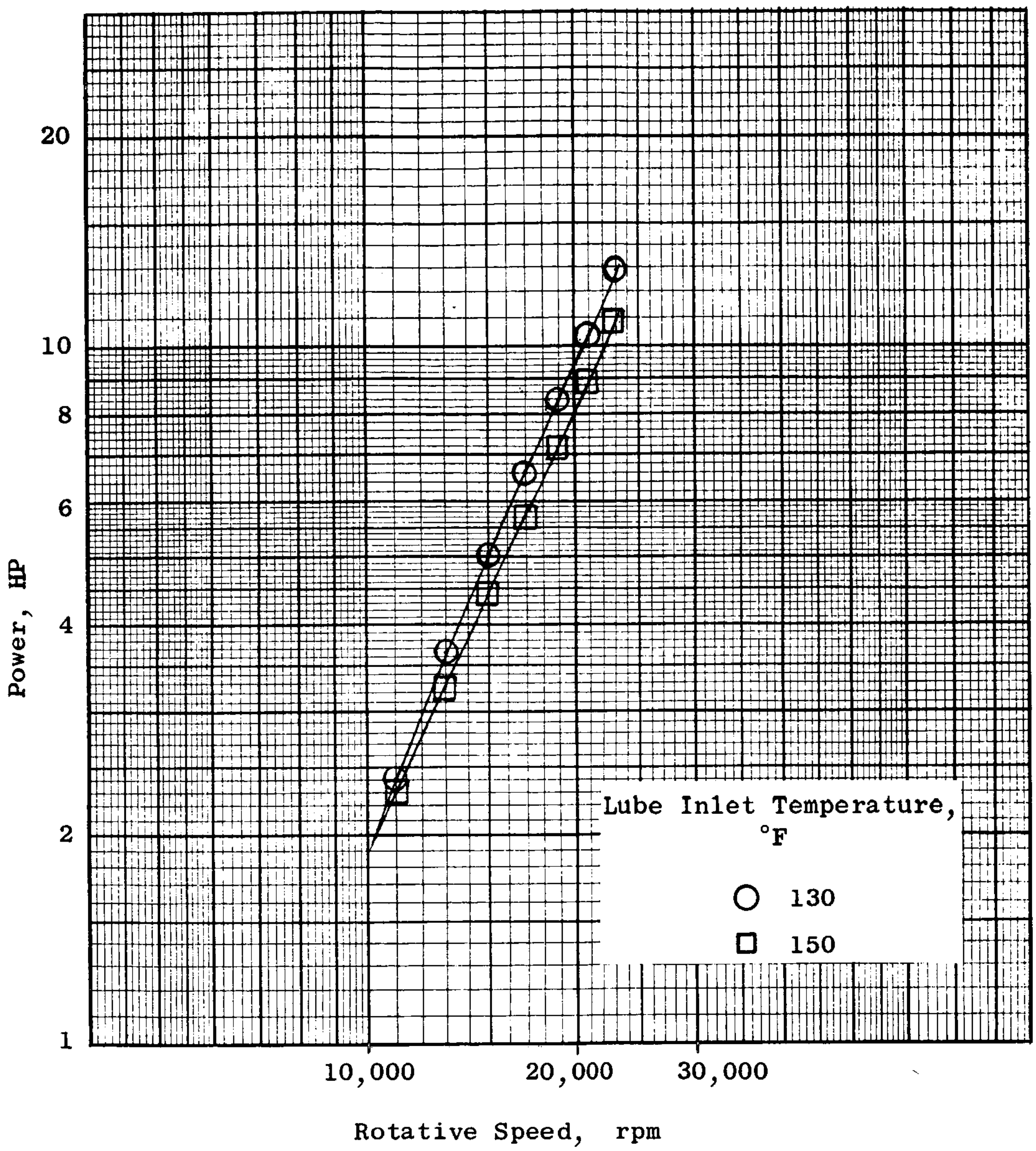


Figure 24a Smoothed Variation of Turbine Bearing Power As A Function of Rotative Speed and Lube Inlet Temperature. Pad Bearing Lube Flow, 2.25 gpm. Test Date, August 17, 1963.

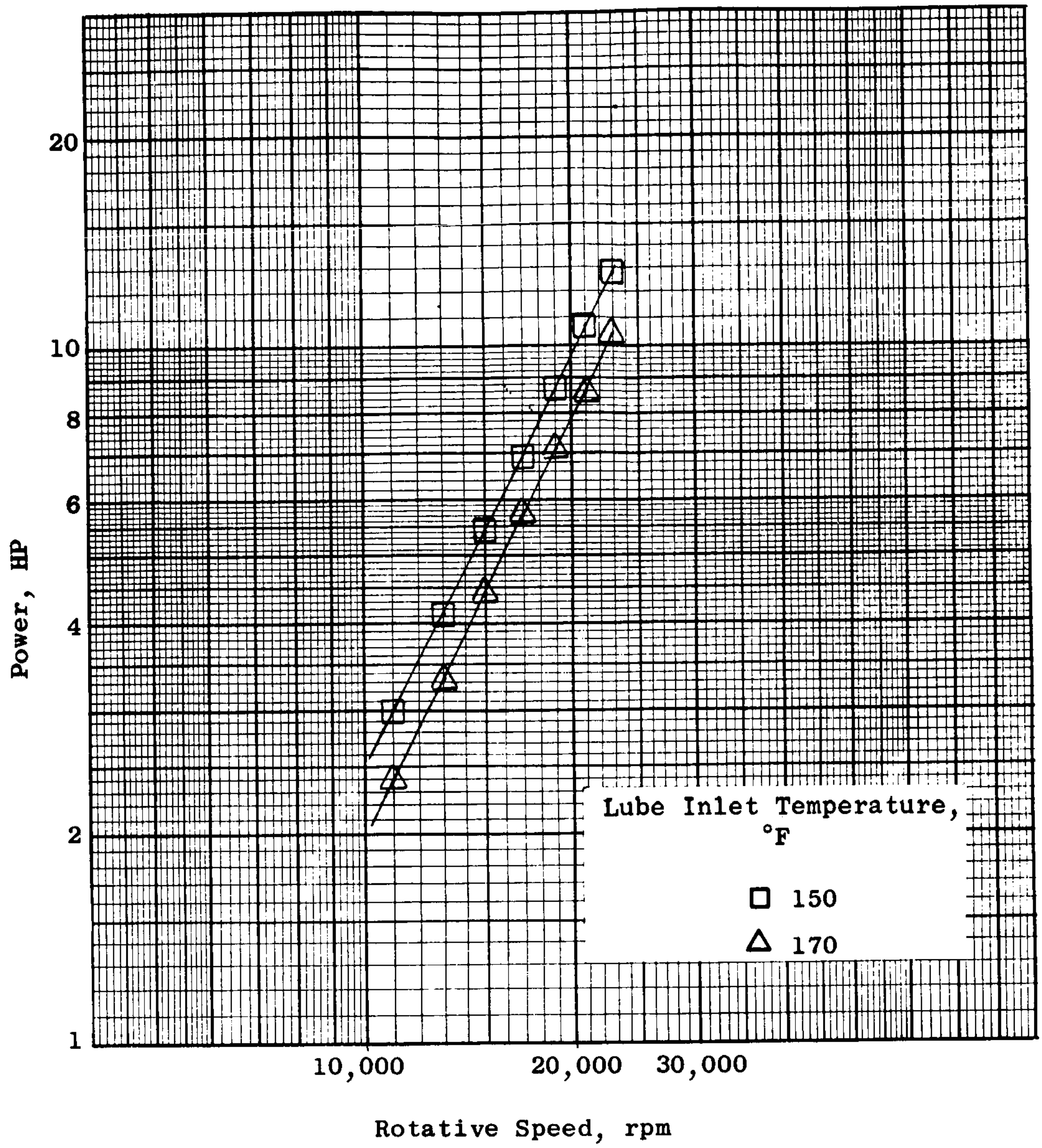


Figure 24b Smoothed Variation of Turbine Bearing Power As A Function of Rotative Speed and Lube Inlet Temperature. Pad Bearing Lube Flow, 4.2 gpm. Test Date, August 17, 1963.

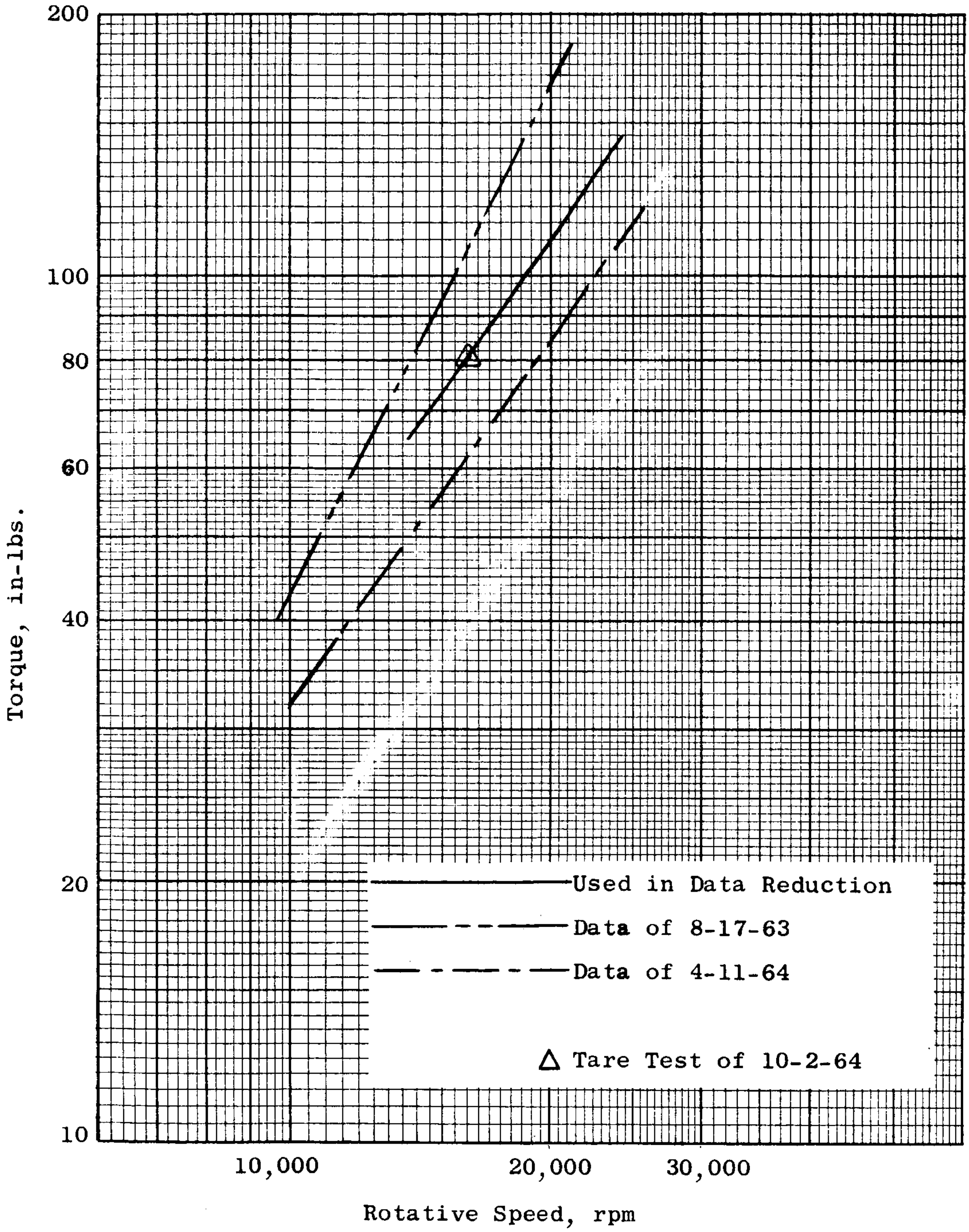


Figure 25. Comparison of Tare Torque Values From Two Methods of Analysis with Estimate of Tare Torque Used for Data Evaluation.

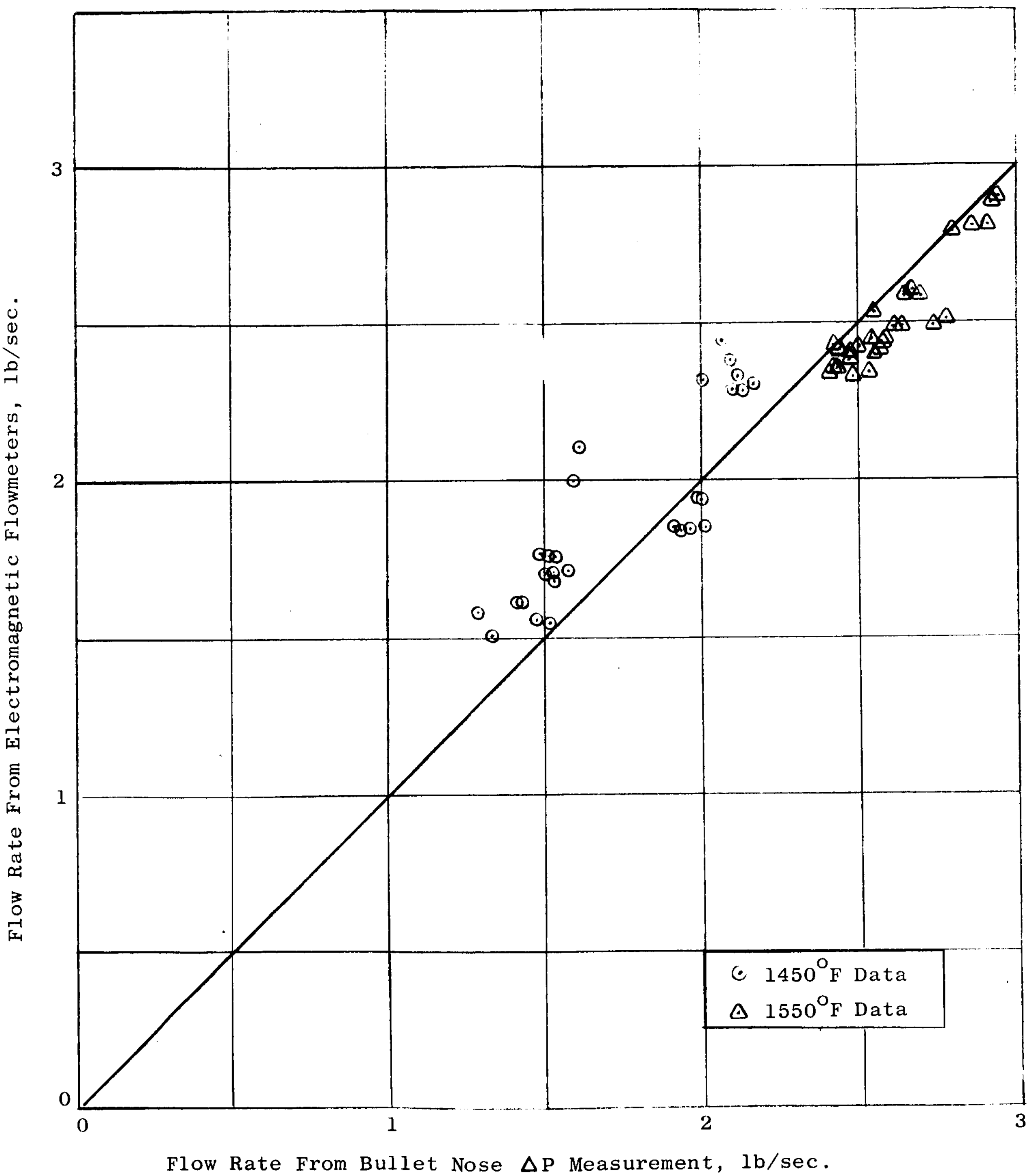


Figure 26. Comparison of Flow Rate Measurements.

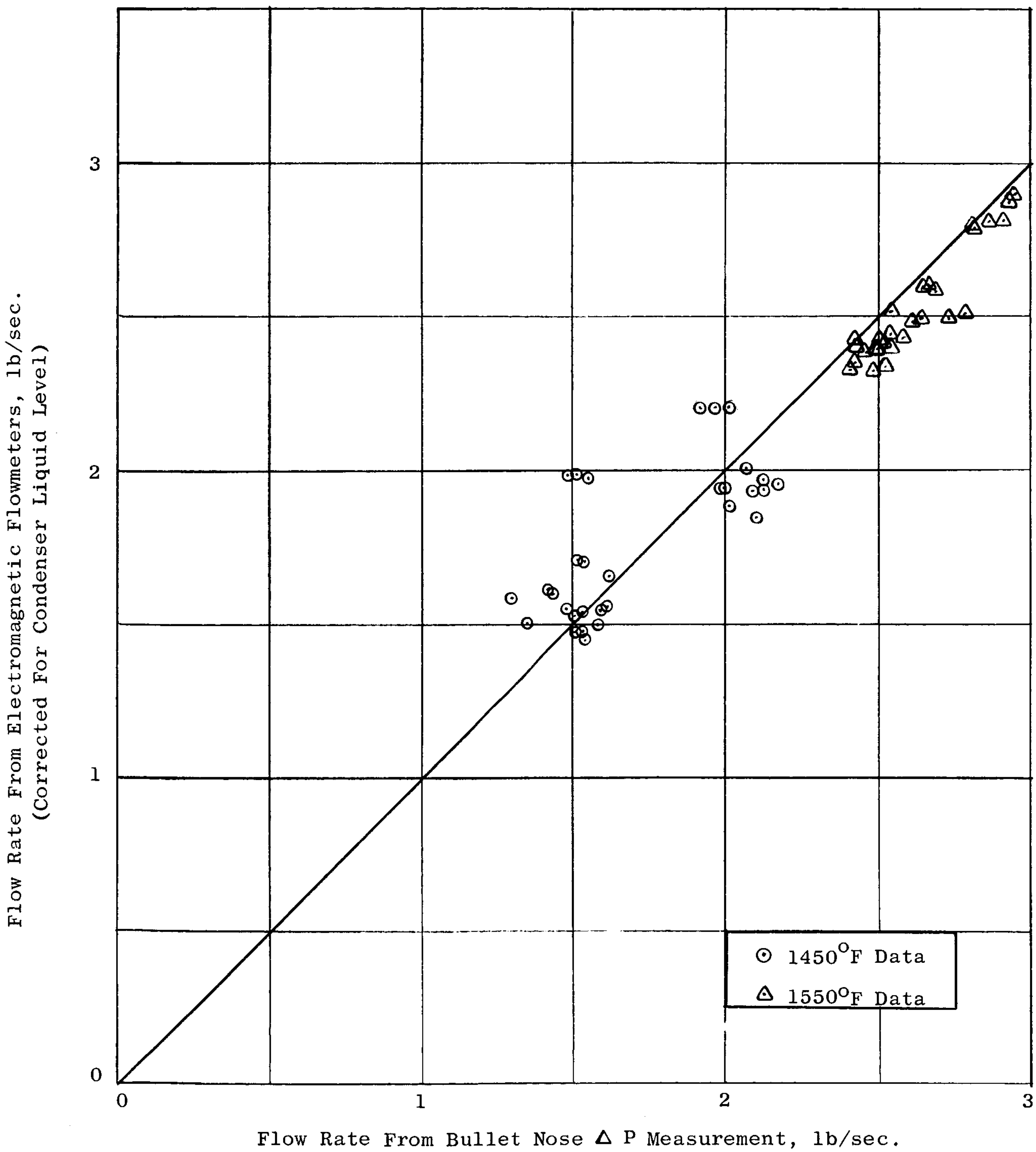


Figure 27. Comparison of Flow Rates Corrected for Condenser Liquid Level.

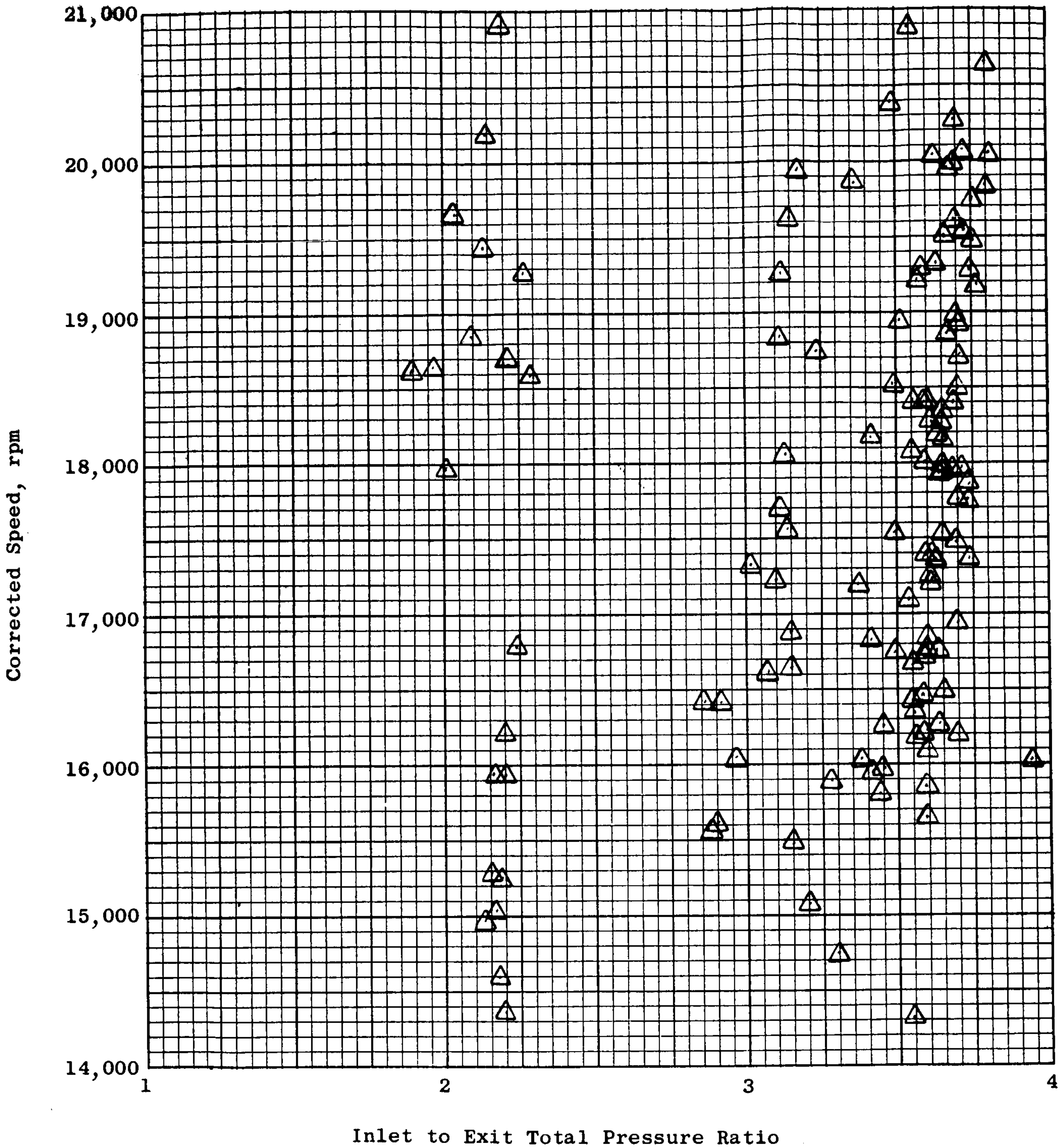


Figure 28 Turbine Performance Parameter Plots for 1450°F Inlet Temperature, Zero Spray Flow.

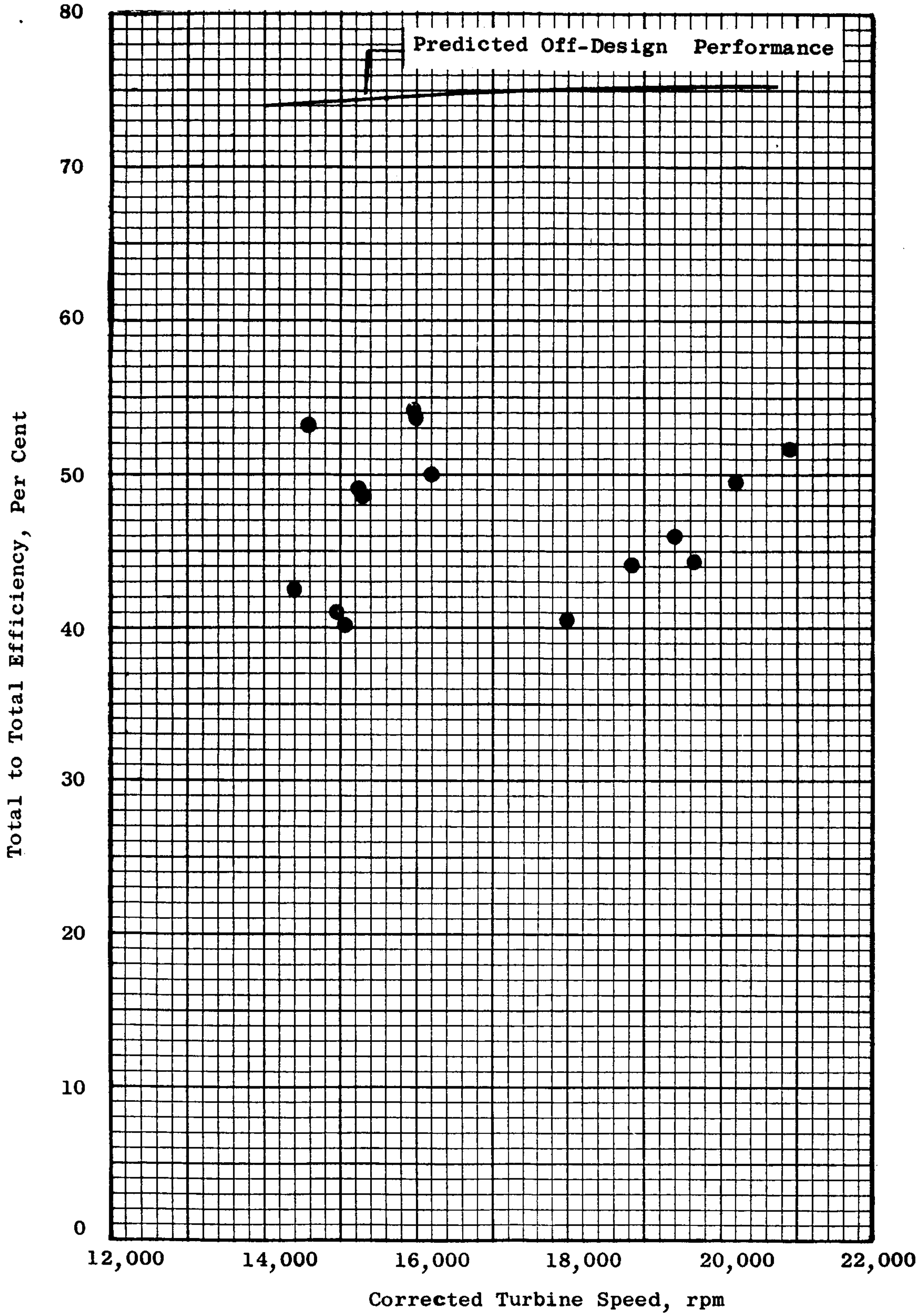


Figure 29. Turbine Performance Comparison for 1450°F Inlet Temperature, Zero Spray Flow. Total to Total Pressure Ratio, 2.1 ± .1.

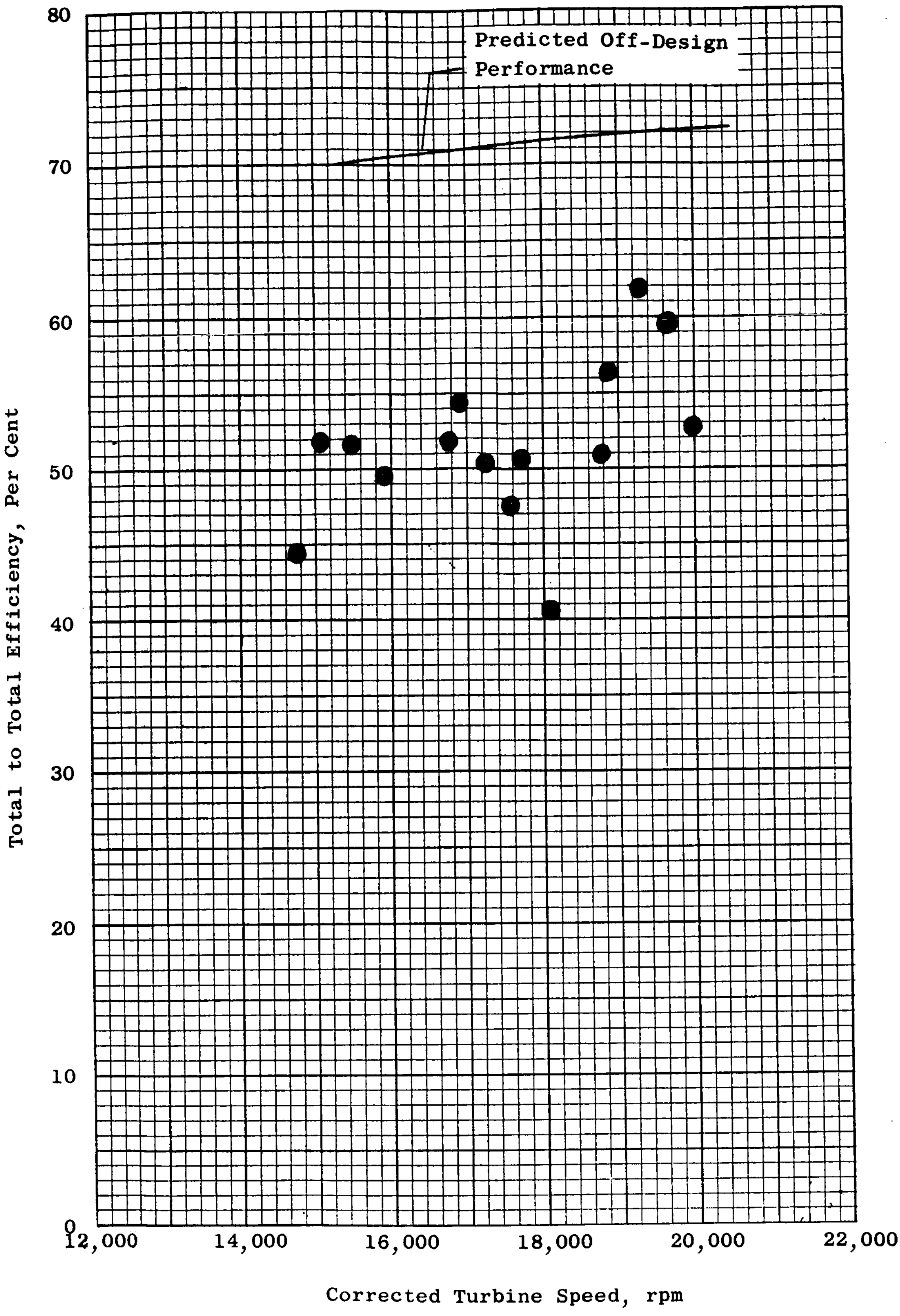


Figure 30 Turbine Performance Comparison for 1450°F Inlet Temperature, Zero Spray Flow. Total to Total Pressure Ratio, 3.2 ±.1.

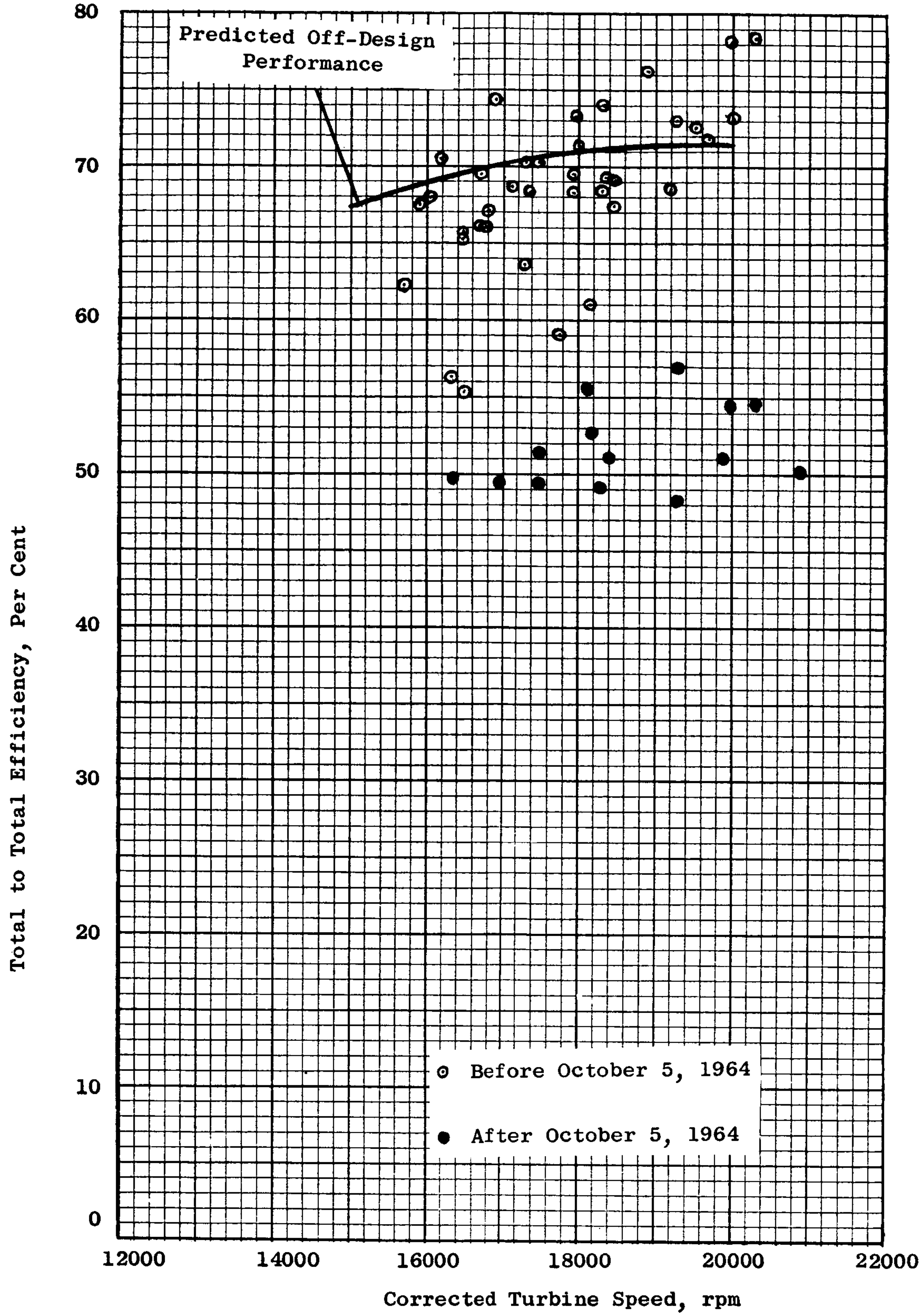


Figure 31. Turbine Performance Comparison for 1450°F Inlet Temperature, Zero Spray Flow, $P_{t1}/P_{t7} = 3.6 \pm .1$.

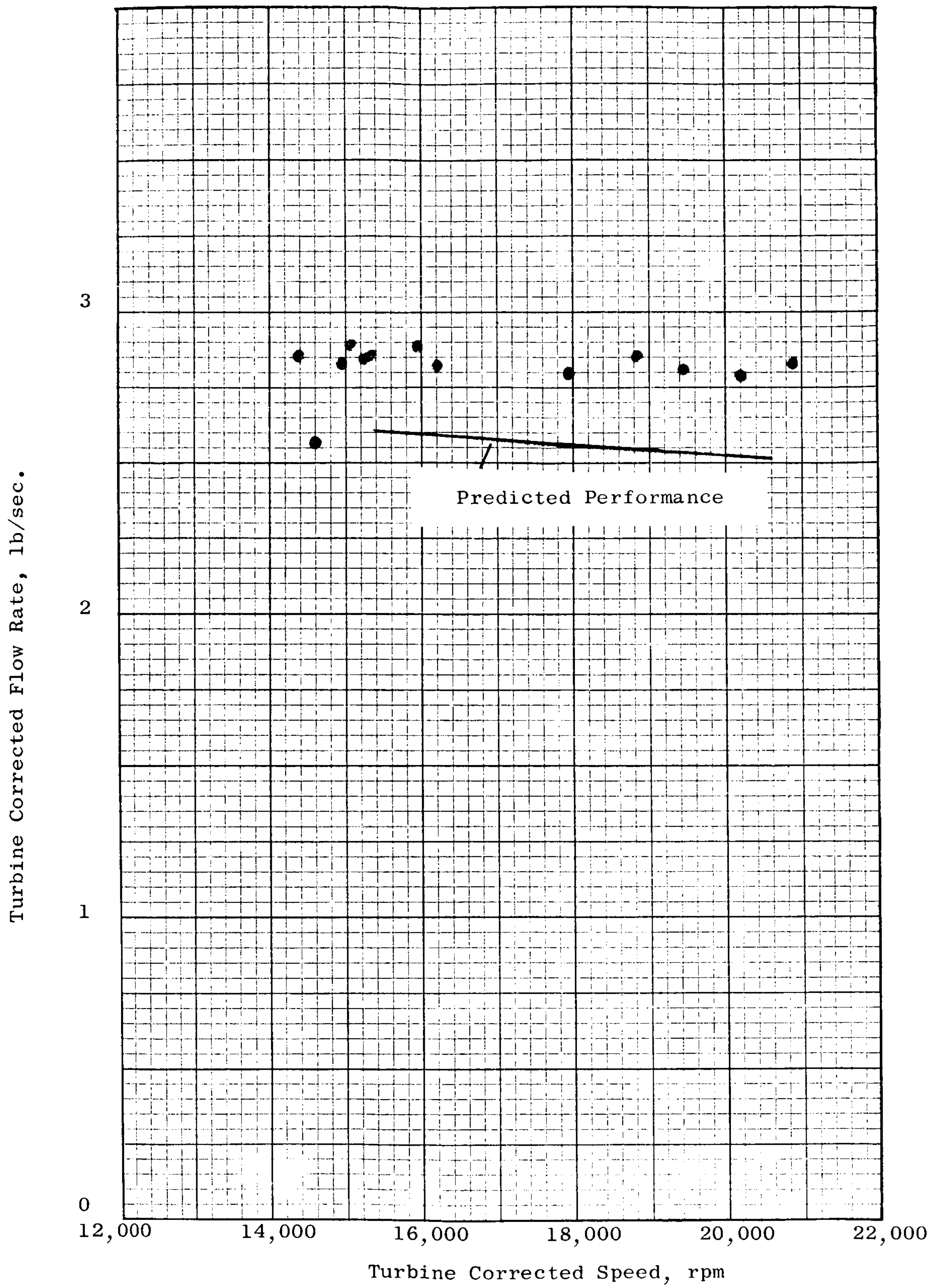


Figure 32. Variation of Turbine Flow Rate with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow. Total to Total Pressure Ratio 2.1 ± 0.1.

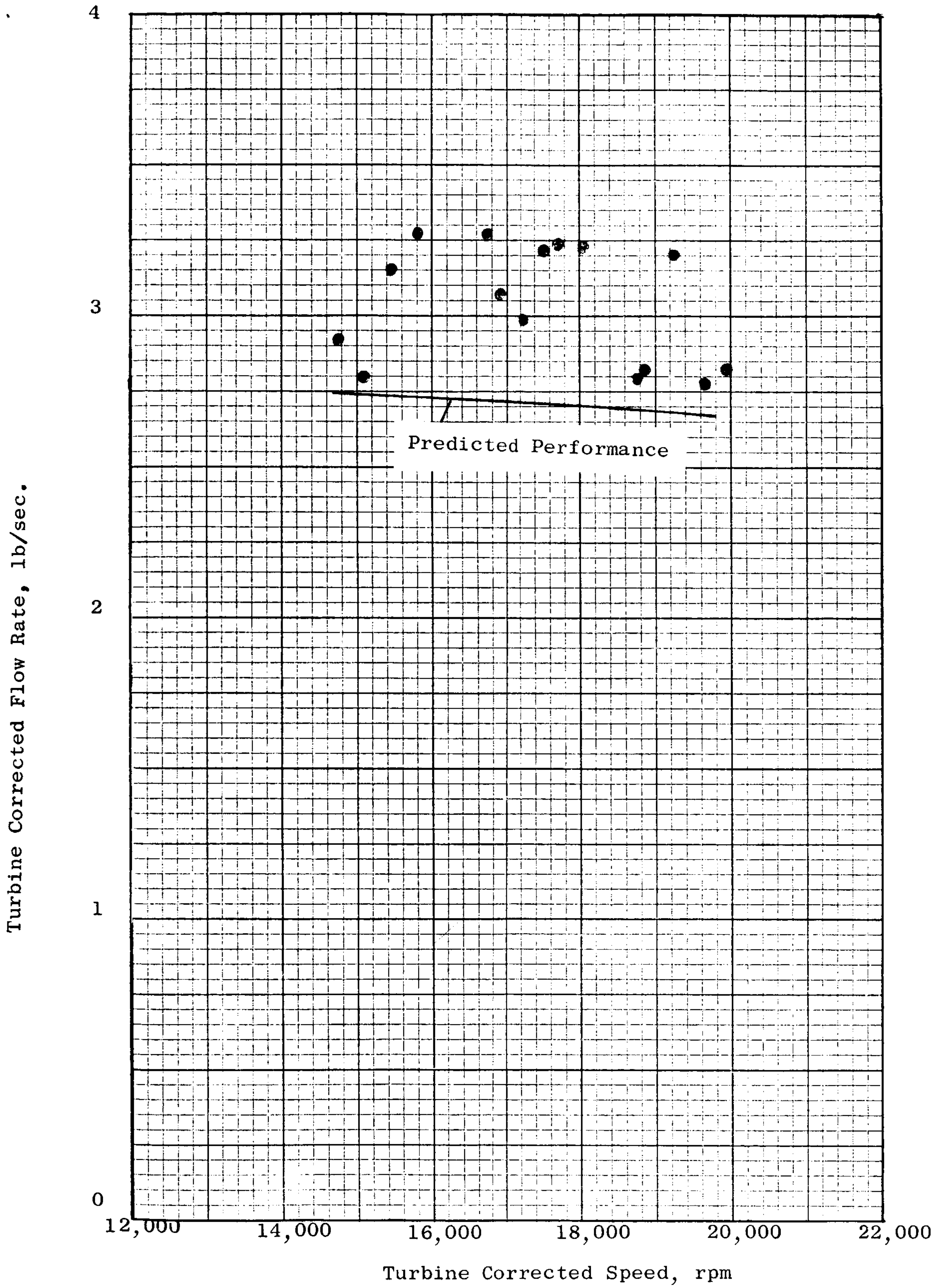


Figure 33. Variation of Turbine Flow Rate with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow. Total to Total Pressure Ratio 3.2 ± 0.1.

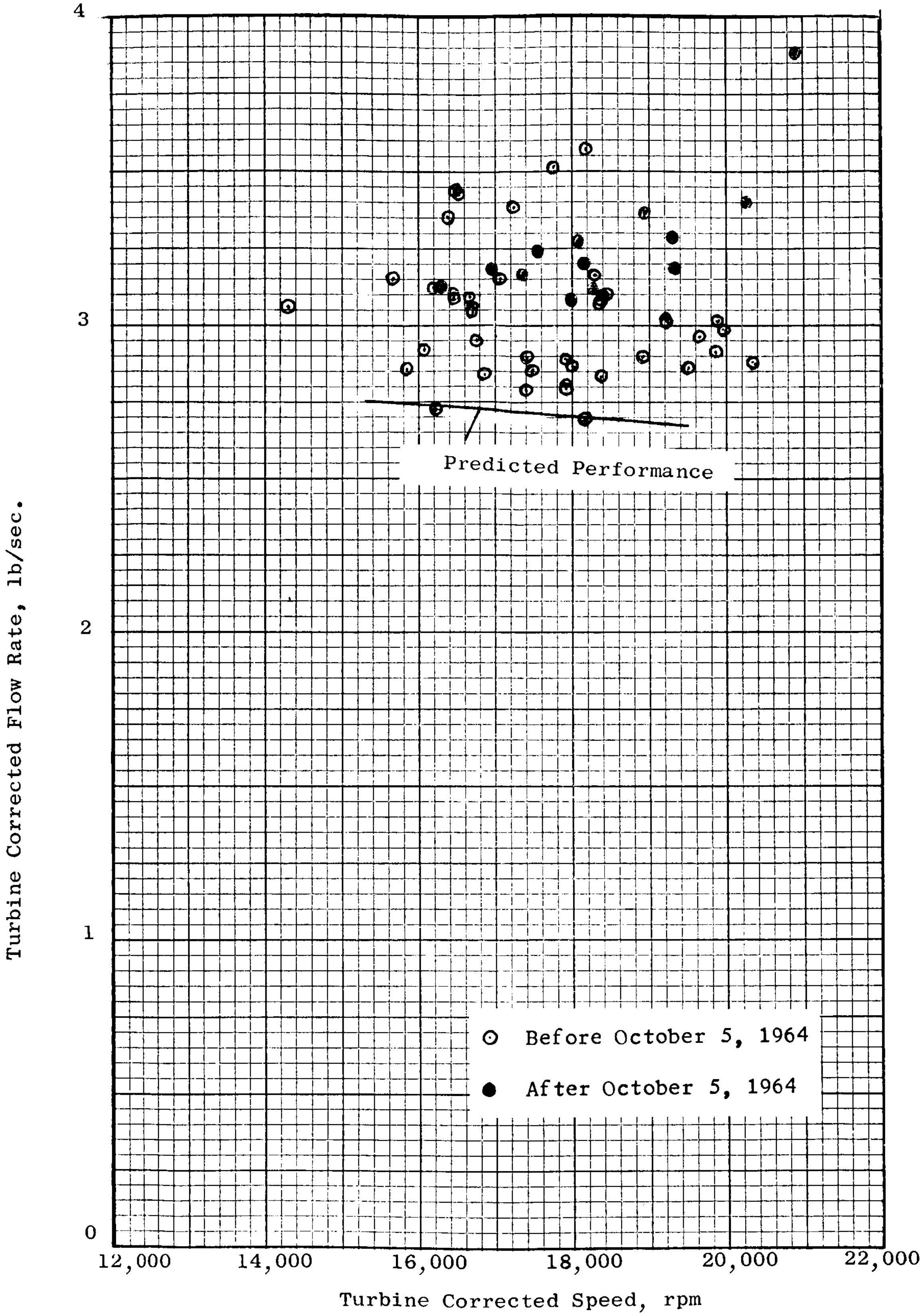


Figure 34. Variation of Turbine Flow Rate with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow, Total to Total Pressure Ratio 3.6 ± 0.1.

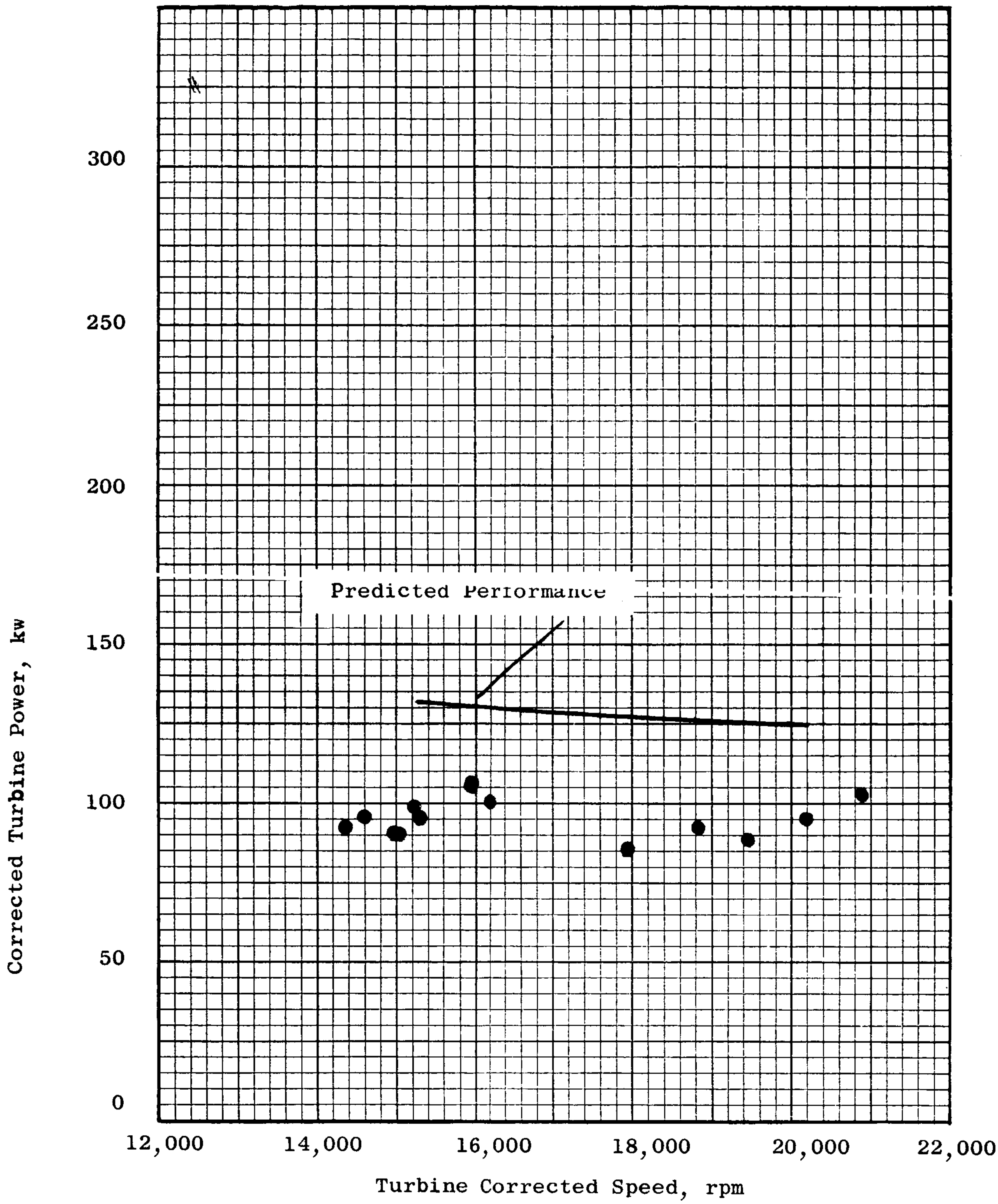


Figure 35. Variation of Turbine Power Output with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow. Total to Total Pressure Ratio 2.1 ± 0.1.

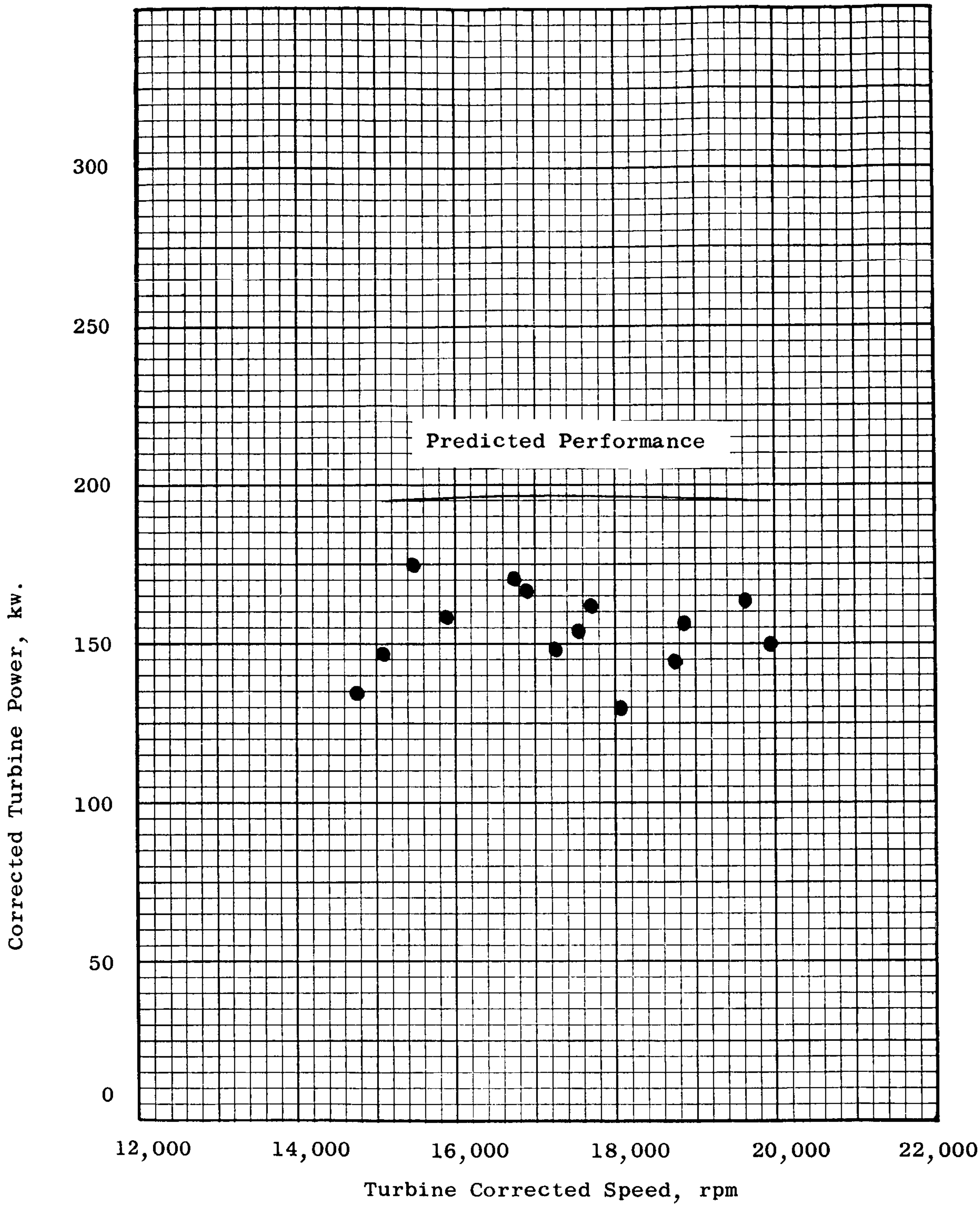


Figure 36. Variation of Turbine Power Output with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow. Total to Total Pressure Ratio 3.2 ± 0.1.

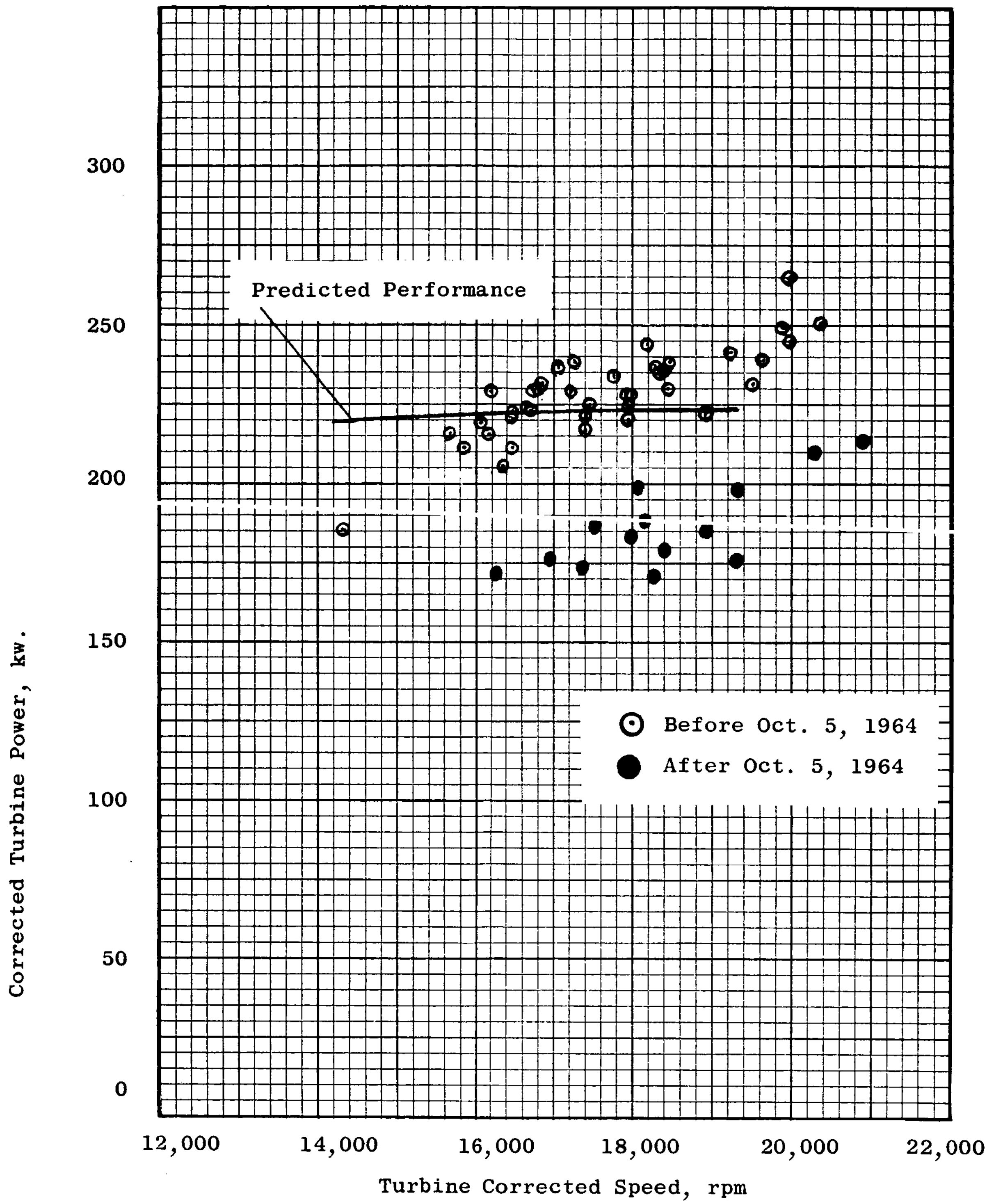


Figure 37. Variation of Turbine Power Output with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow. Total to Total Pressure Ratio 3.6 ± 0.1.

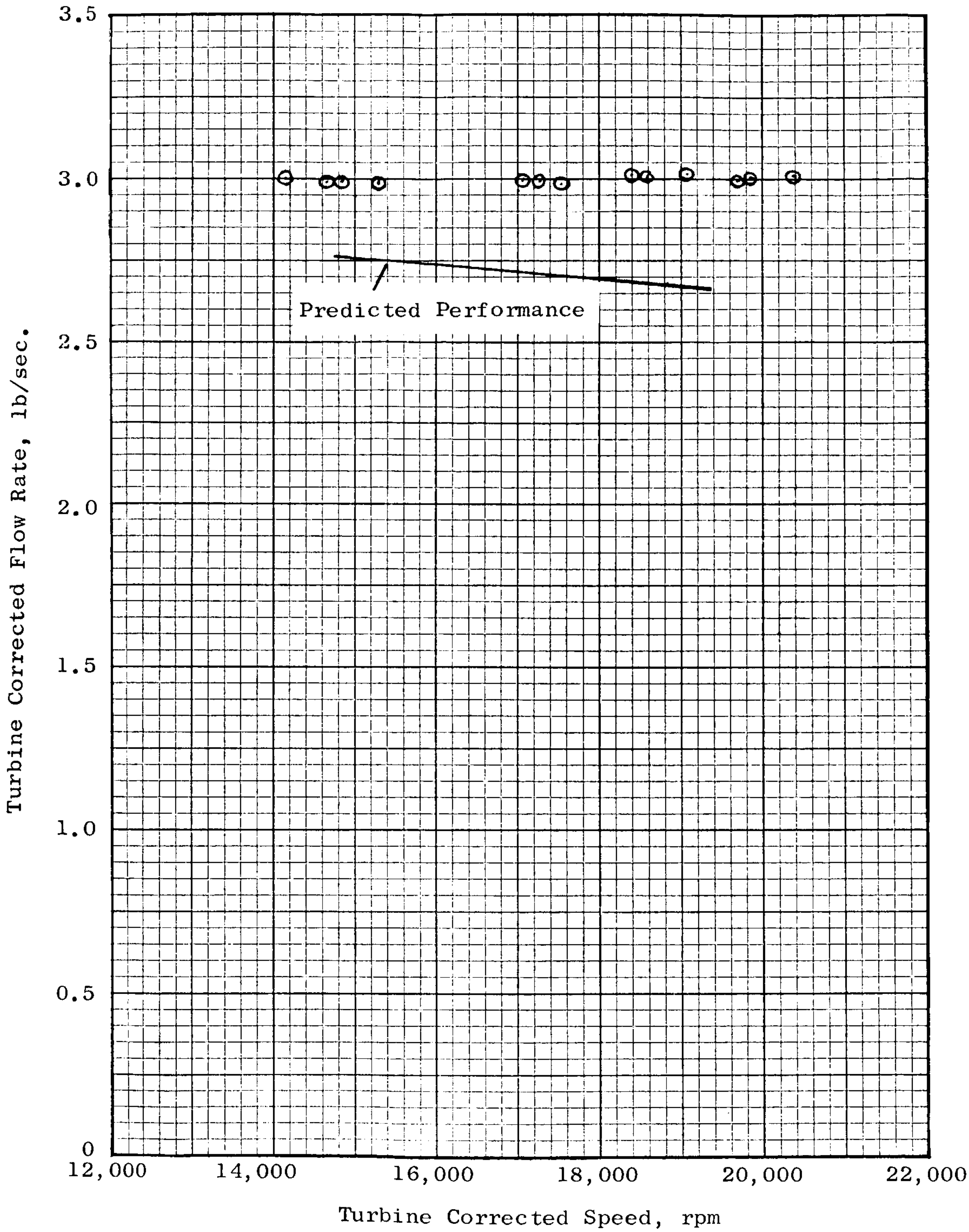


Figure 38. Variation of Turbine Flow Rate with Rotative Speed for 1550°F Inlet Temperature, Zero Spray Flow. Total to Total Pressure Ratio, 3.0 ± 0.1.

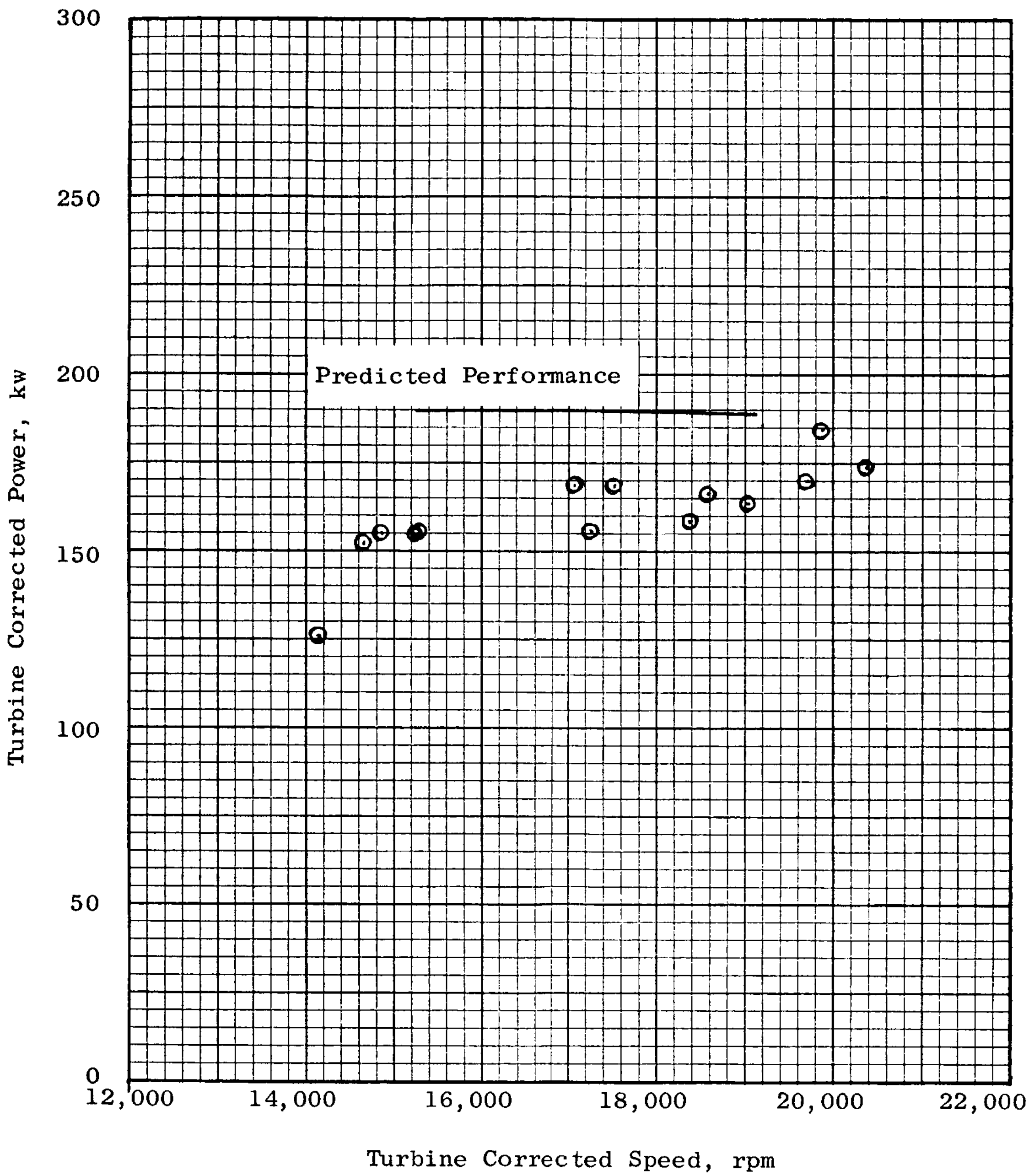


Figure 39. Variation of Turbine Power Output with Rotative Speed for 1550°F Inlet Temperature, Zero Spray Flow. Total to Total Pressure Ratio 3.0 ± 0.1.

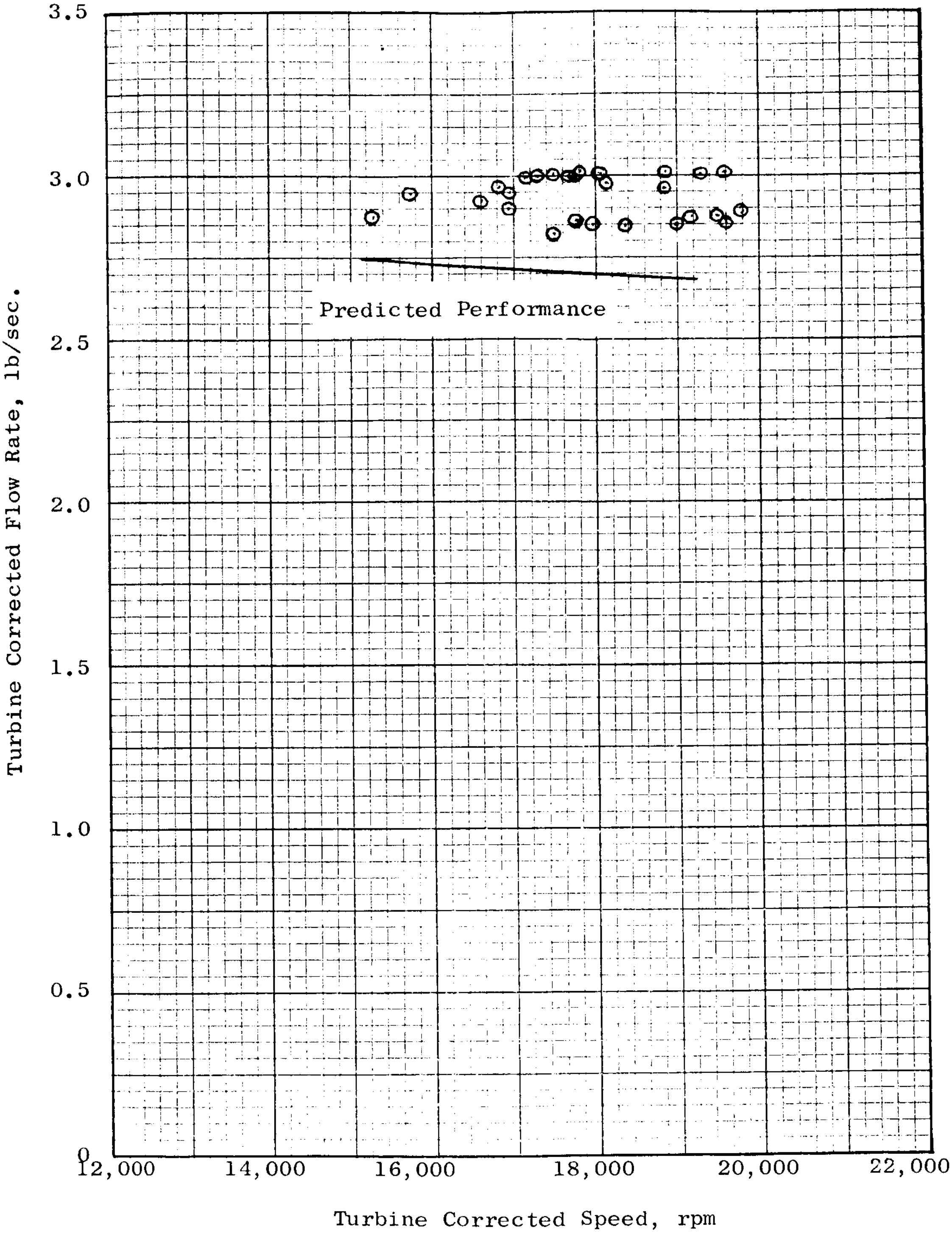


Figure 40. Variation of Turbine Flow Rate with Rotative Speed for 1550°F Inlet Temperature, Zero Spray Flow Total to Total Pressure Ratio, 3.8 ± 0.1.

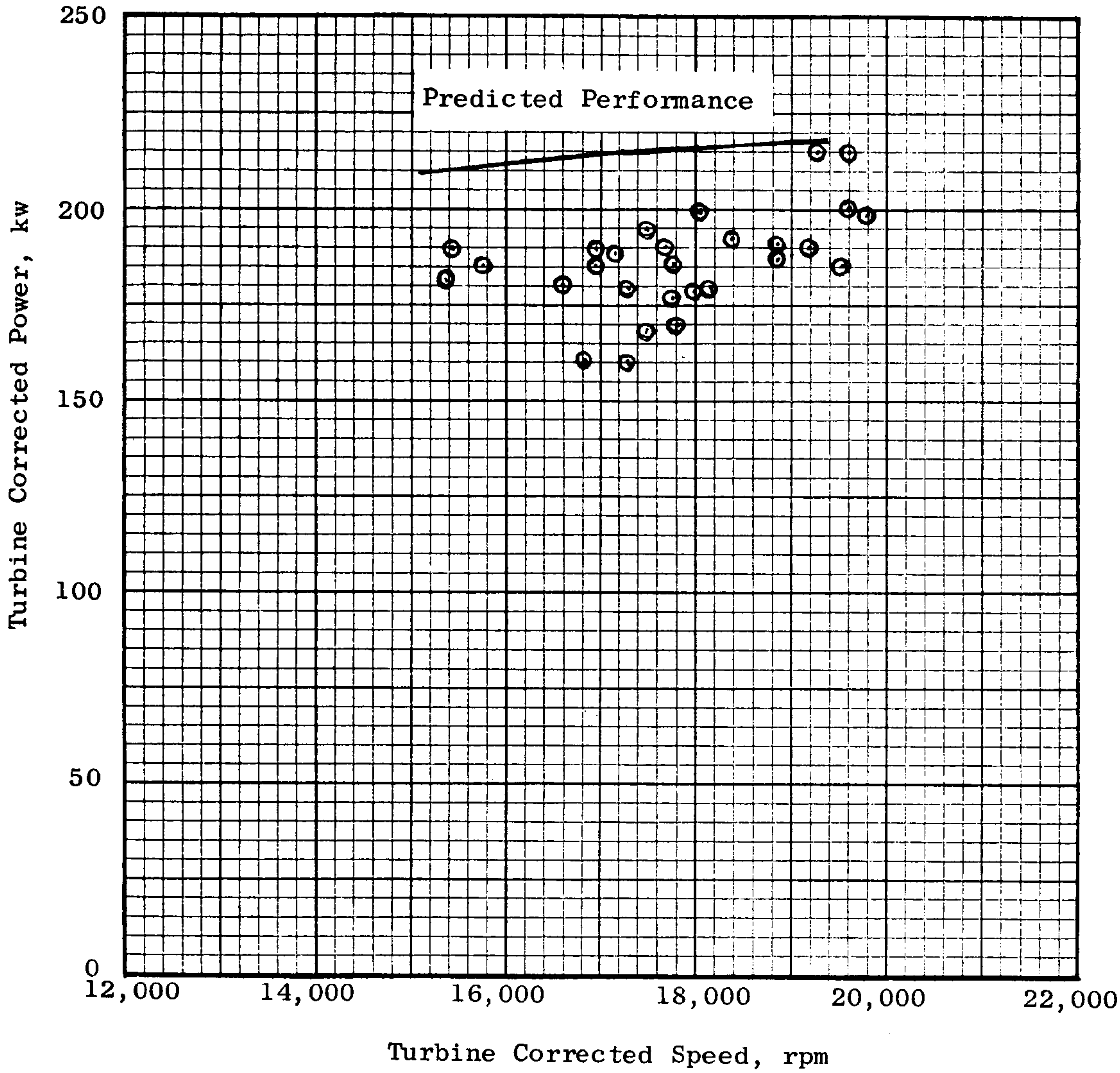


Figure 41. Variation of Turbine Power Output with Rotative Speed for 1550°F Inlet Temperature, Zero Spray Flow. Total to Total Pressure Ratio, 3.8 ± 0.1.

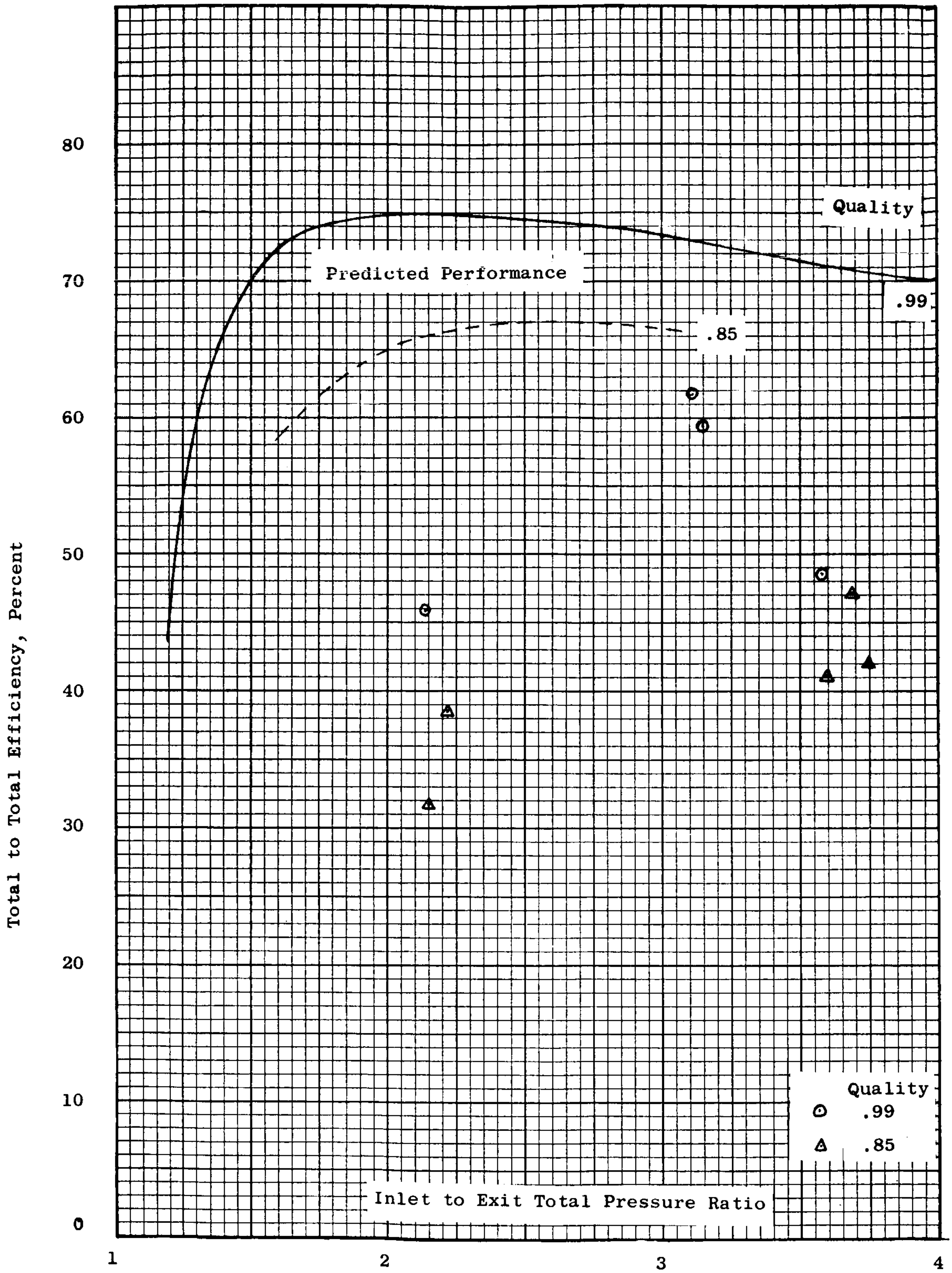


Figure 42. Effect of Inlet Quality on Turbine Efficiency
1450°F Inlet Temperature Corrected Speed, 19400 rpm.

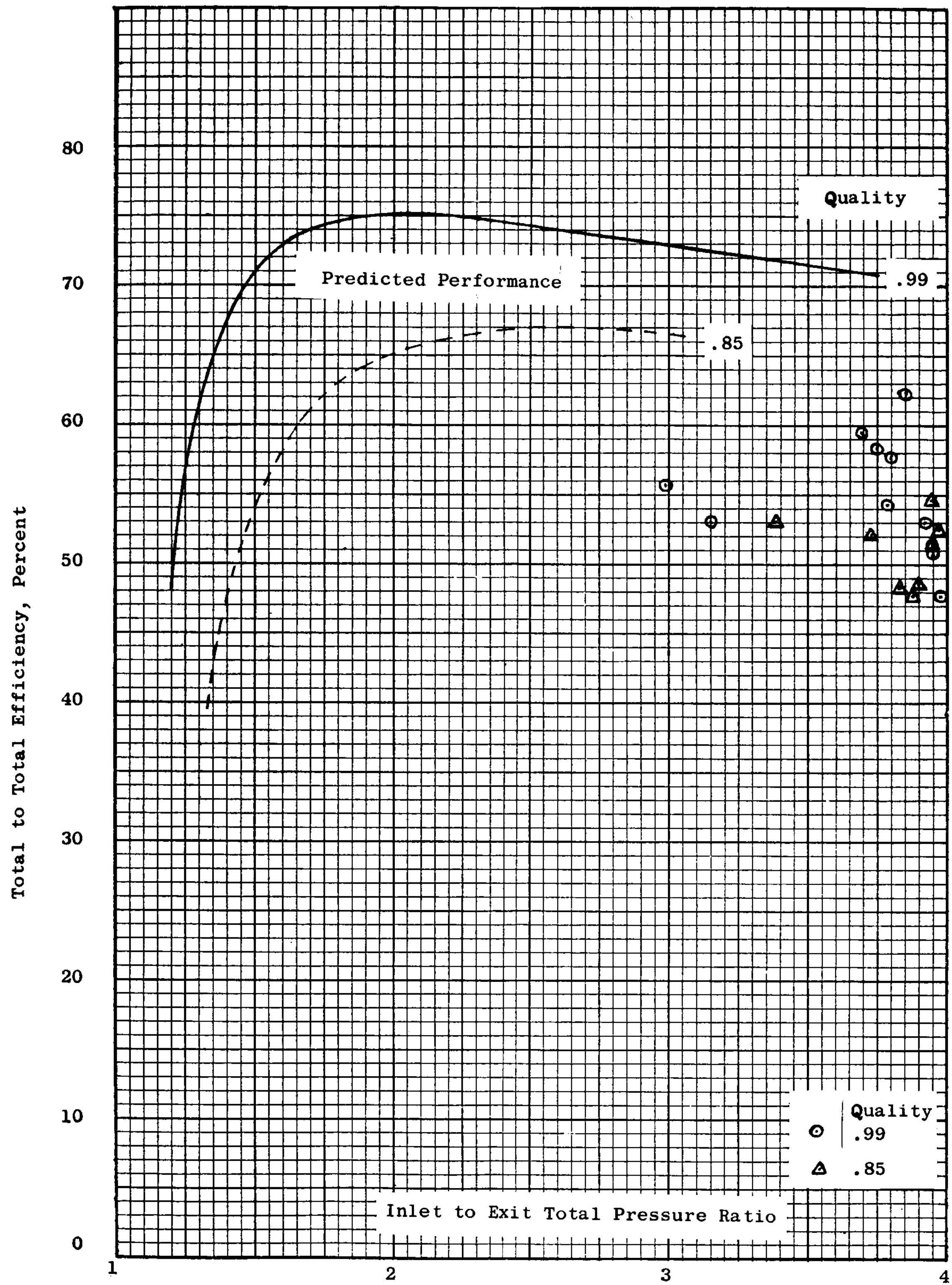


Figure 43. Effect of Inlet Quality on Turbine Efficiency 1550°F Inlet Temperature Corrected Speed, 19200 rpm.

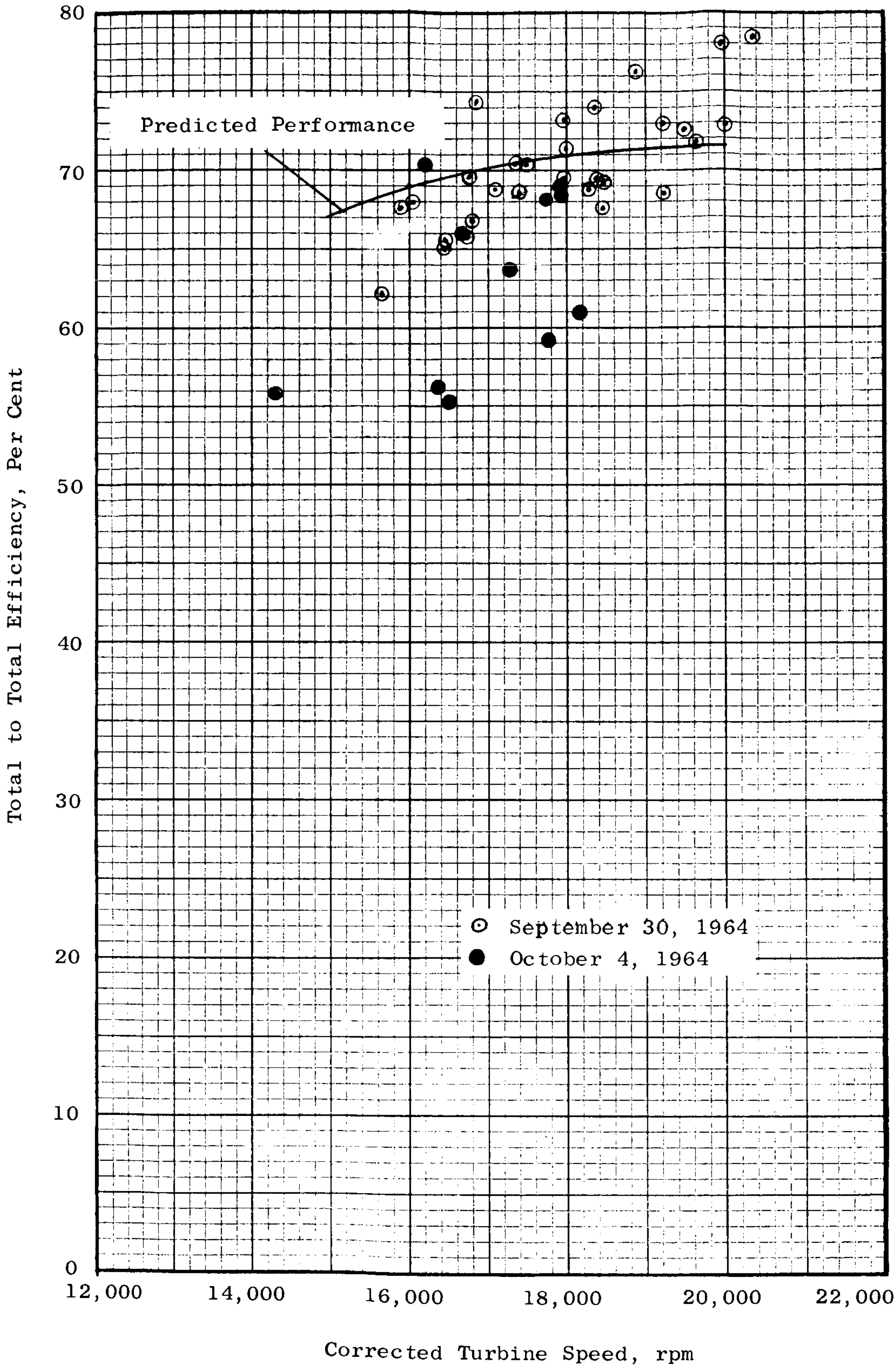
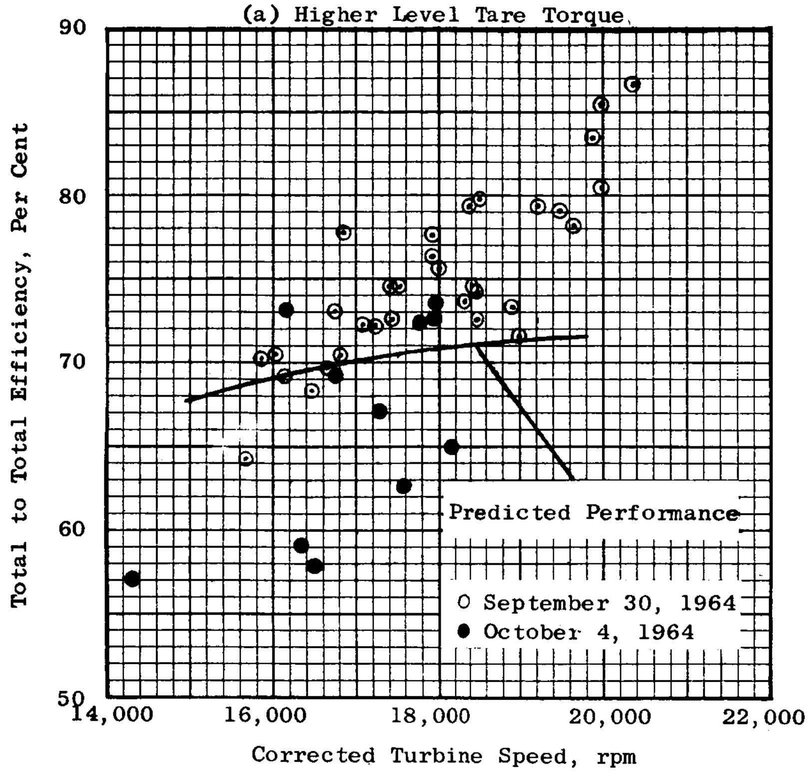


Figure 44. Variation of Turbine Efficiency with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow, Total to Total Pressure Ratio, 3.6 ± 0.1.

(a) Higher Level Tare Torque



(b) Lower Level Tare Torque

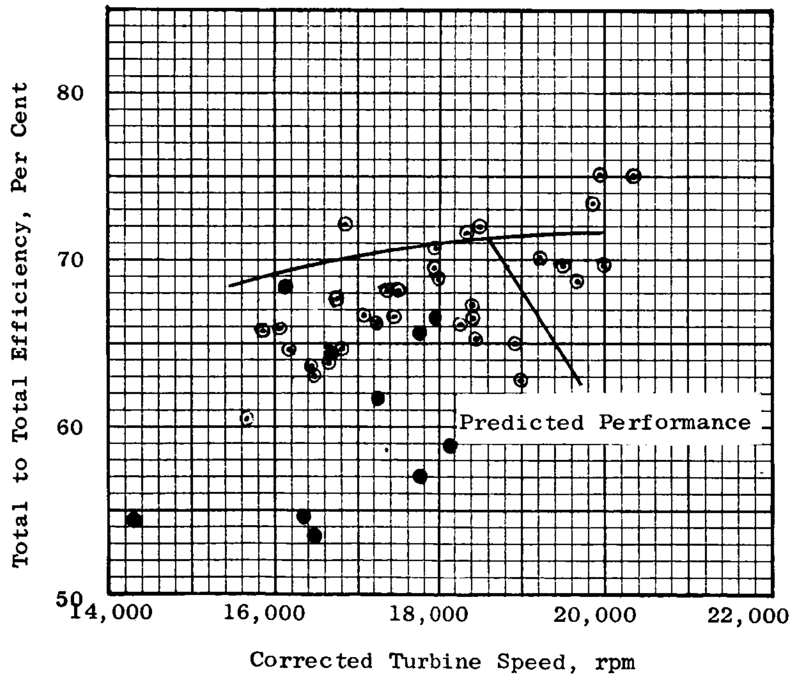


Figure 45. Variation of Turbine Efficiency with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow, Total to Total Pressure Ratio, 3.6 ± 0.1.

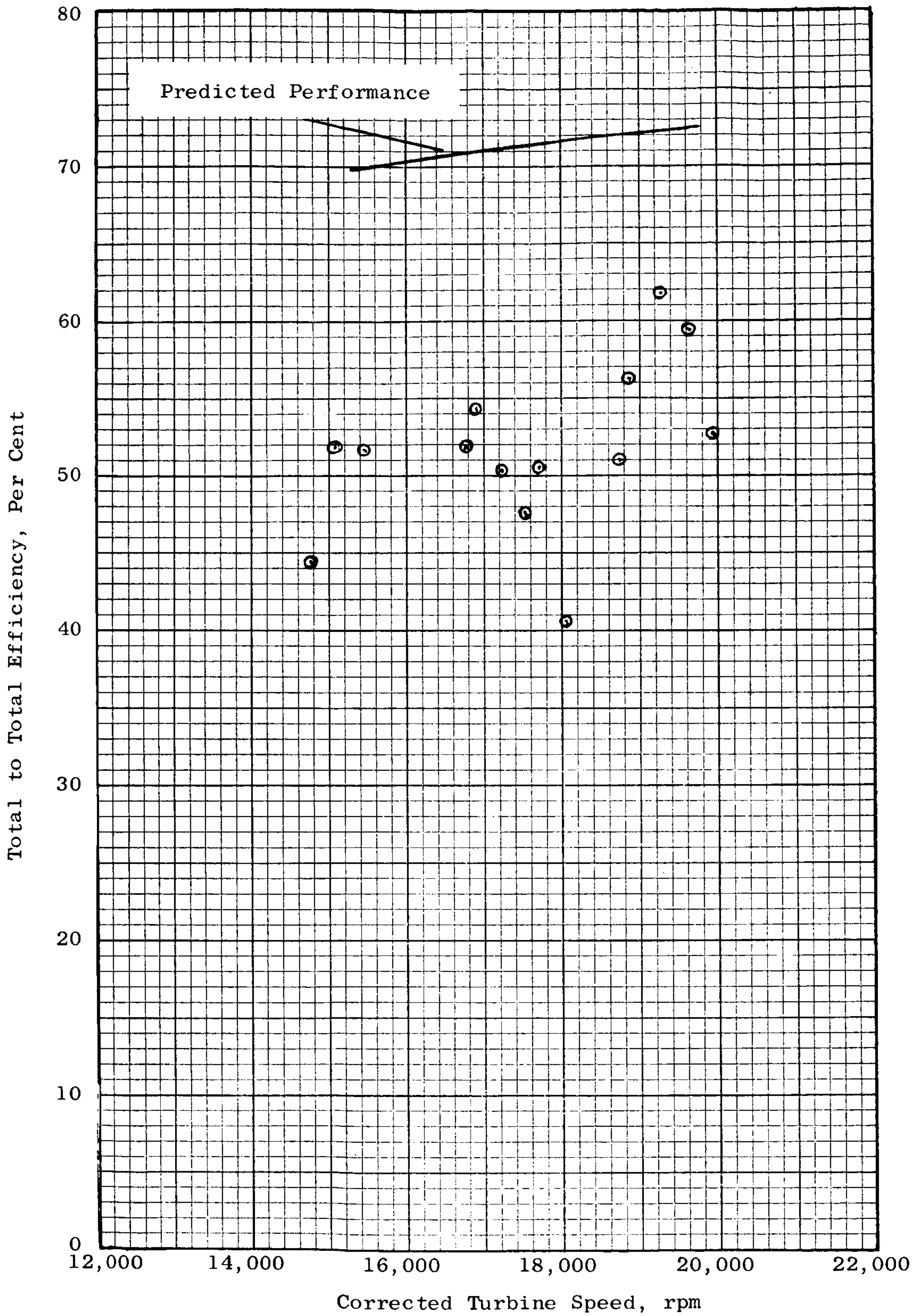


Figure 46. Variation of Turbine Efficiency with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow, Total to Total Pressure Ratio, 3.2 ± 0.1.

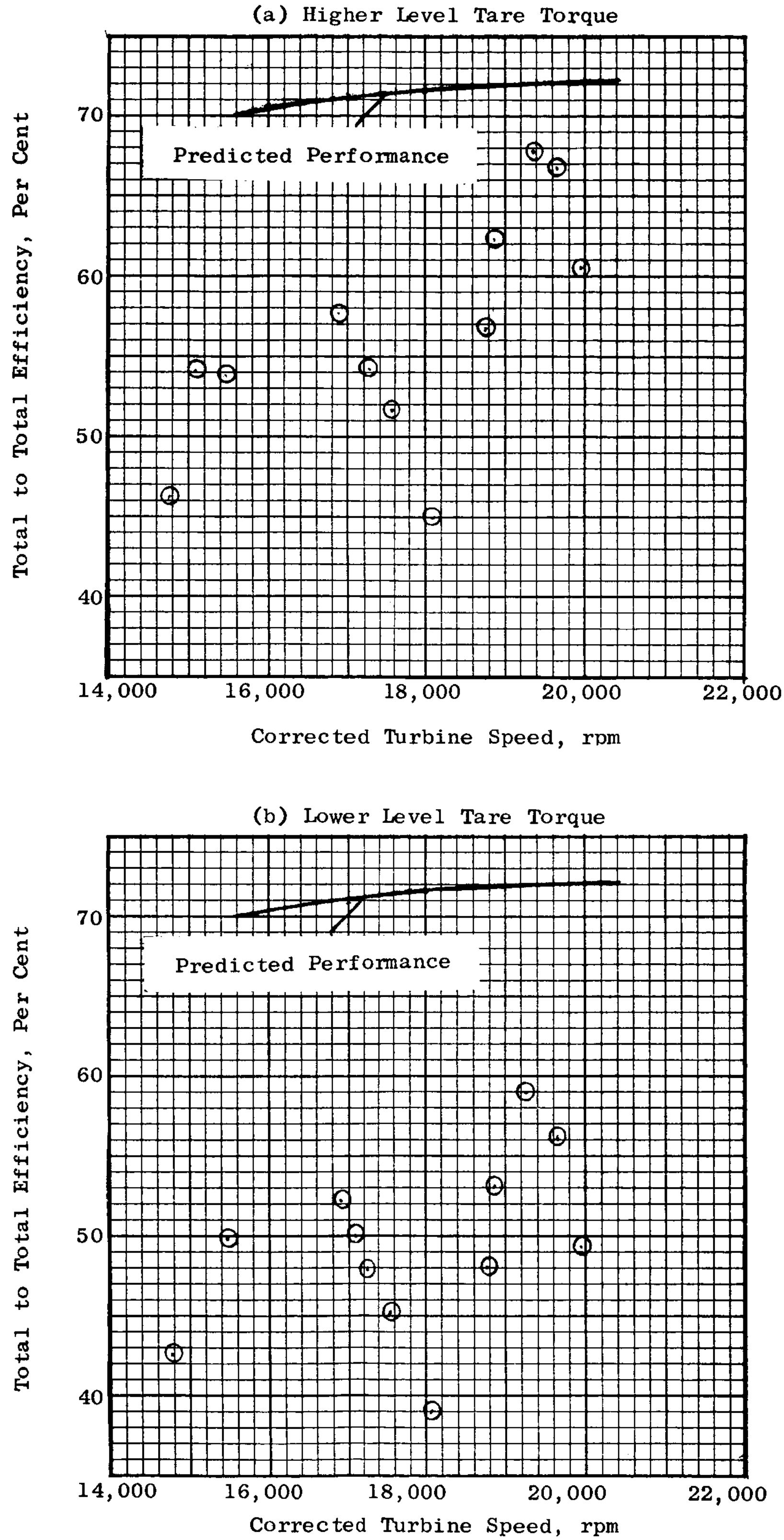


Figure 47. Variation of Turbine Efficiency with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow, Total to Total Pressure Ratio, 3.2 ± 0.1.

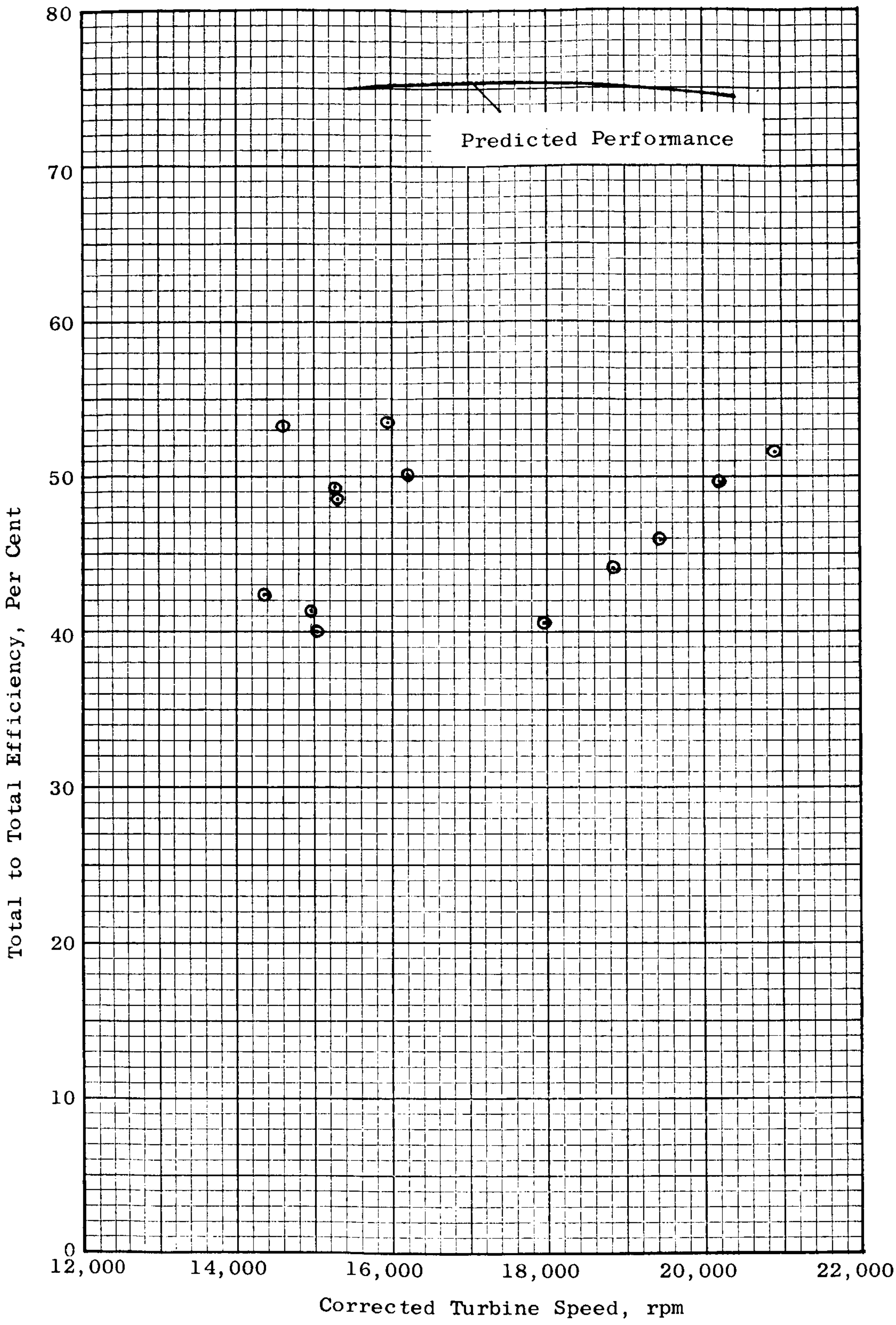
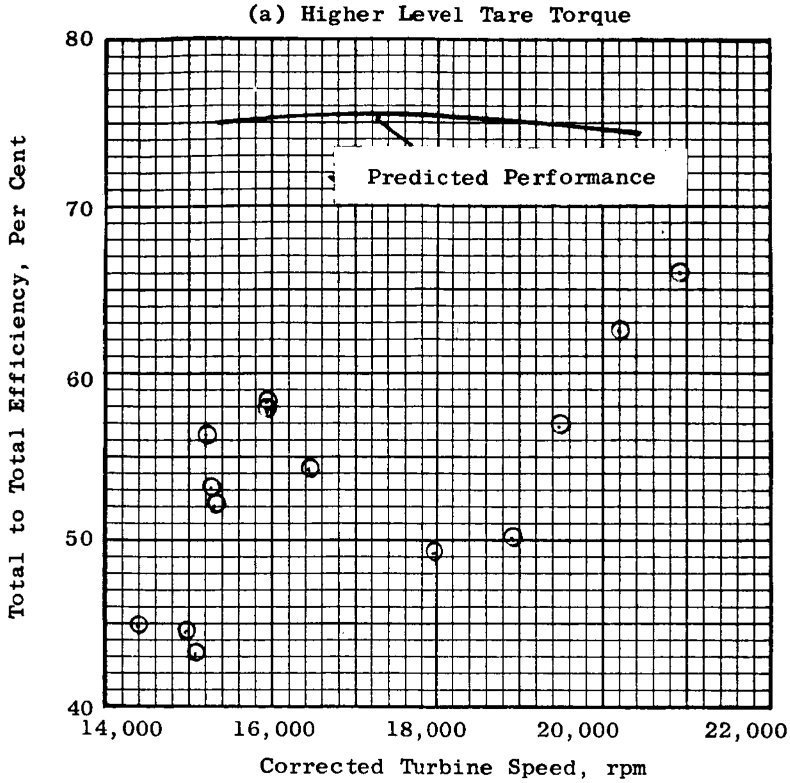


Figure 48. Variation of Turbine Efficiency with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow, Total to Total Pressure Ratio, 2.1 ± 0.1.



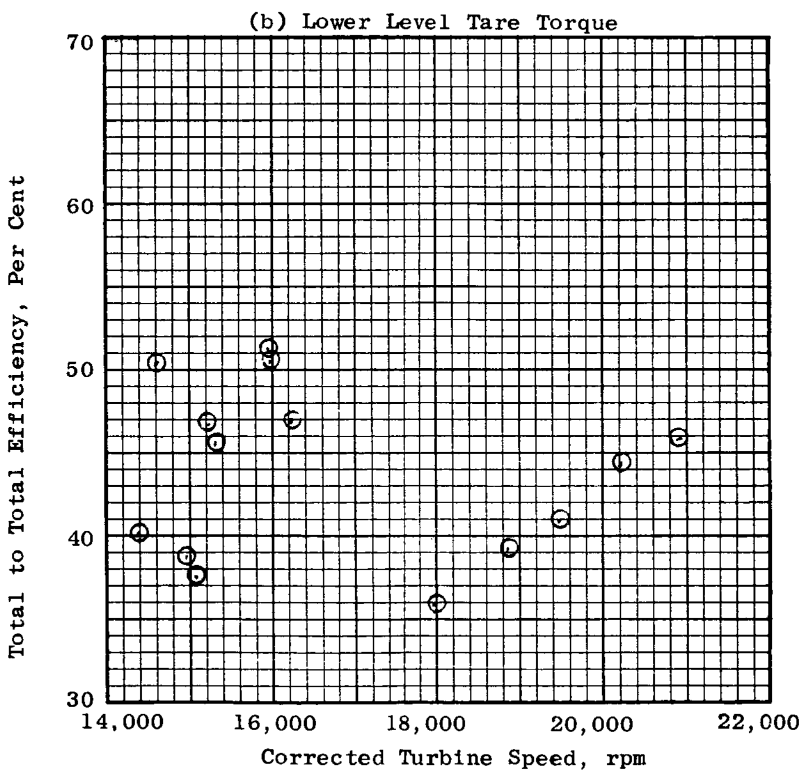


Figure 49. Variation of Turbine Efficiency with Rotative Speed for 1450°F Inlet Temperature, Zero Spray Flow, Total to Total Pressure Ratio, 2.1 ± 0.1.

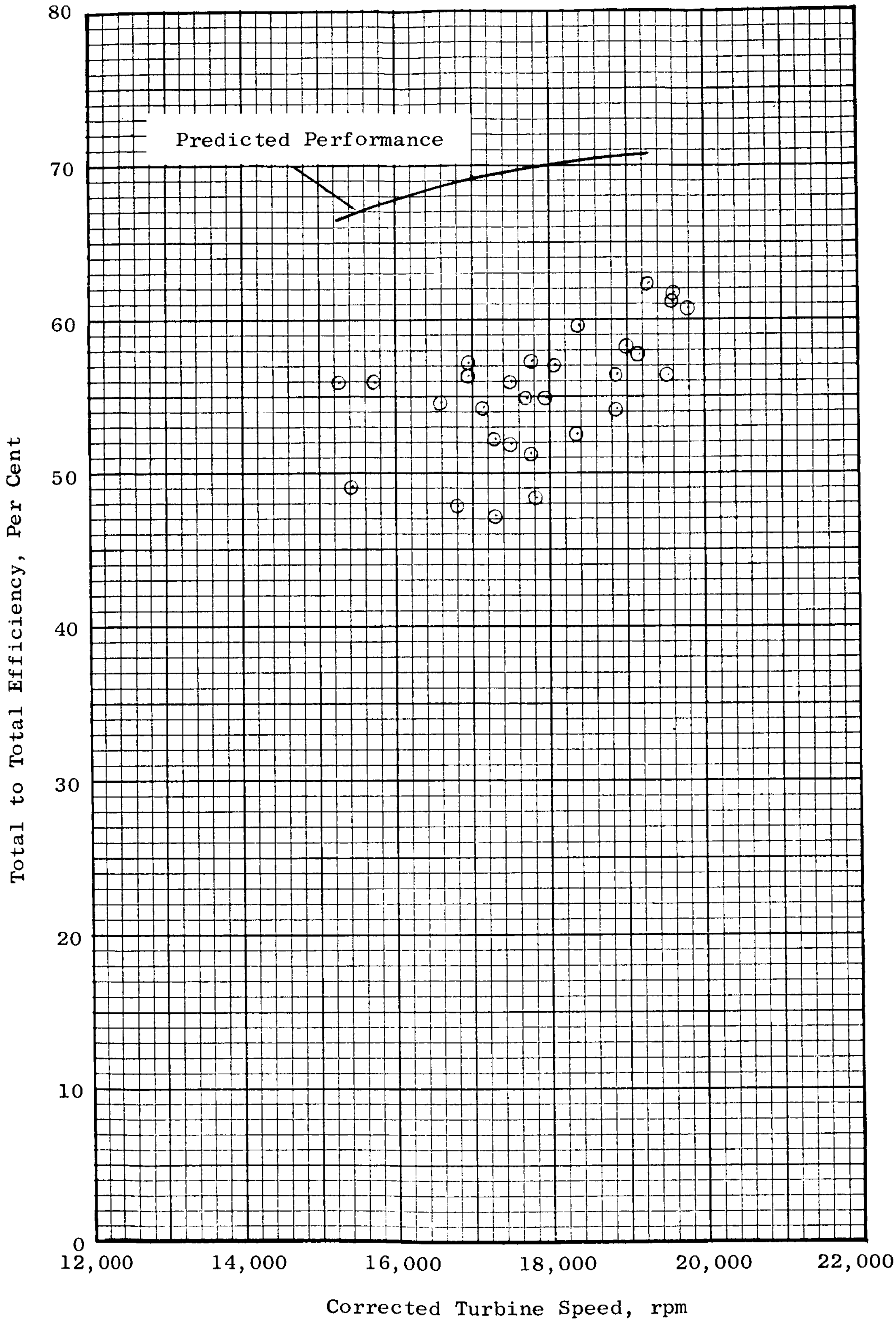
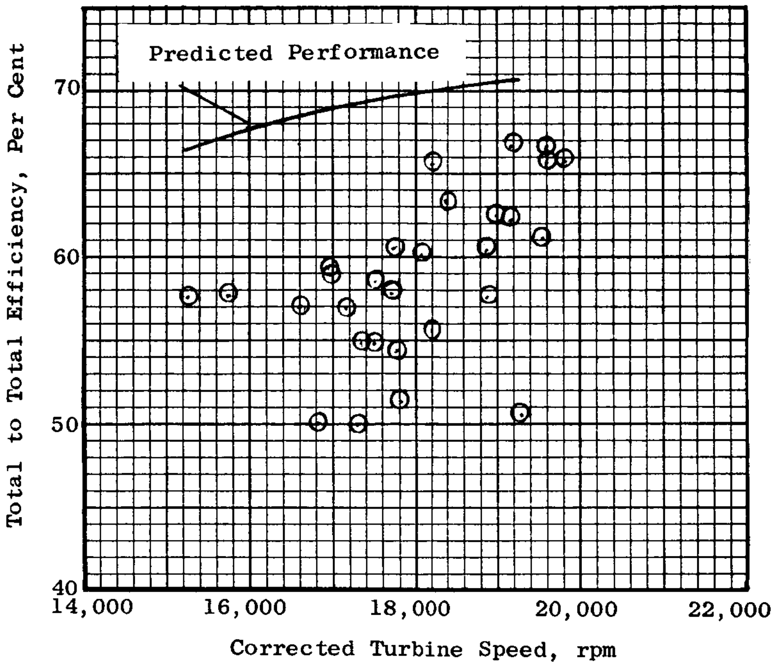


Figure 50. Variation of Turbine Efficiency with Rotative Speed for 1550°F Inlet Temperature, Zero Spray Flow, Total to Total Pressure Ratio, 3.8 ± 0.1.

(a) Higher Level Tare Torque



(b) Lower Level Tare Torque

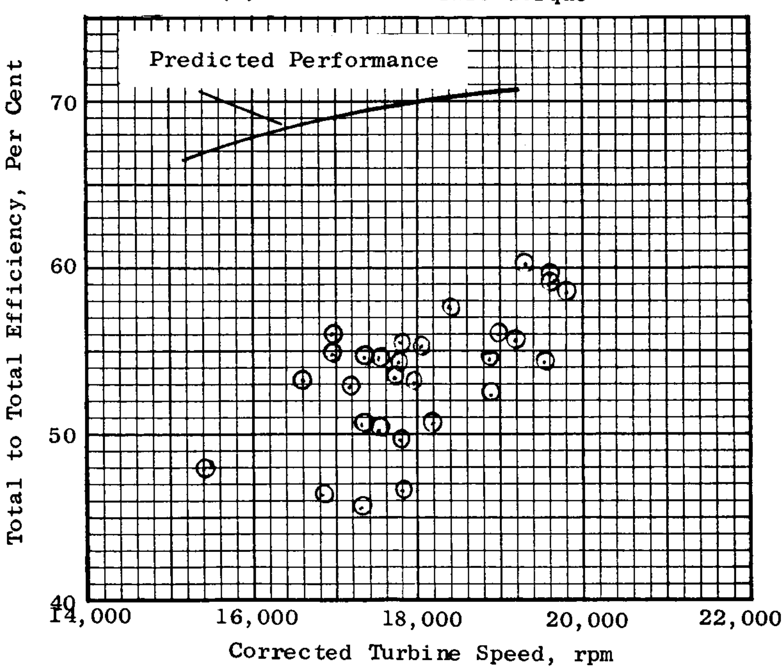


Figure 51. Variation of Turbine Efficiency with Rotative Speed for 1550°F Inlet Temperature. Zero Spray Flow, Total to Total Pressure Ratio, 3.8 ± 0.1.

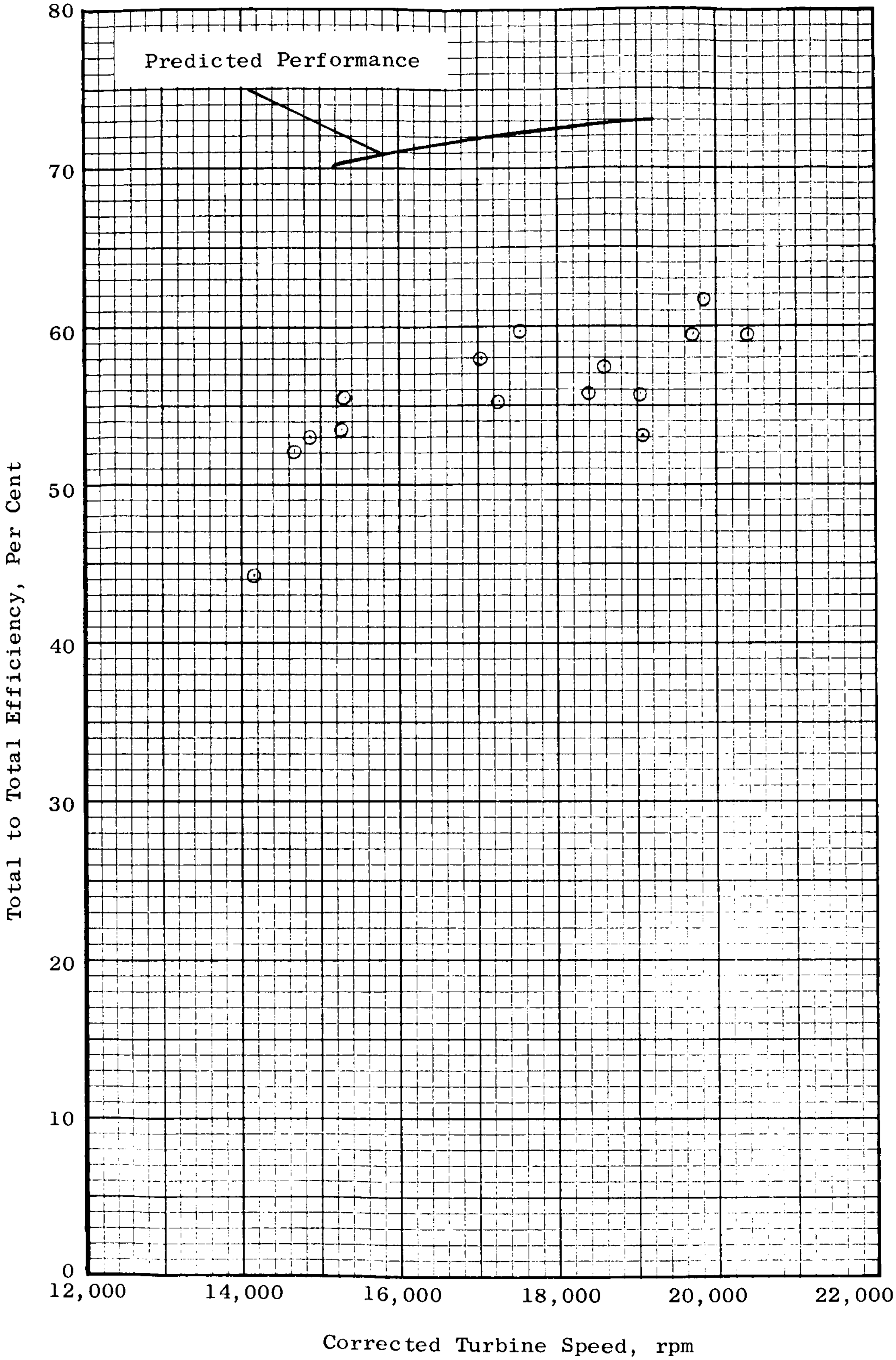
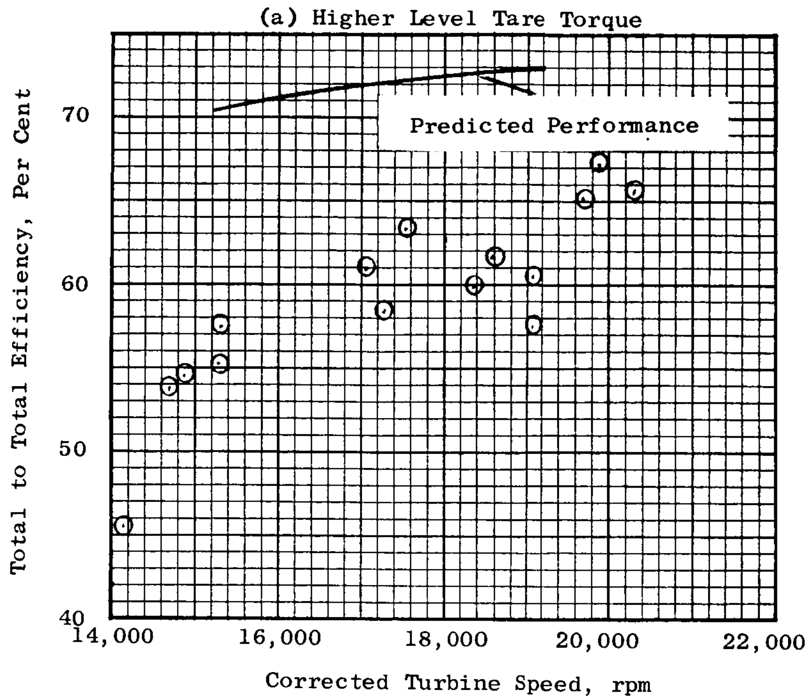


Figure 52. Variation of Turbine Efficiency with Rotative Speed for 1550°F Inlet Temperature, Zero Spray Flow, Total to Total Pressure Ratio, 3.0 ± 0.1.



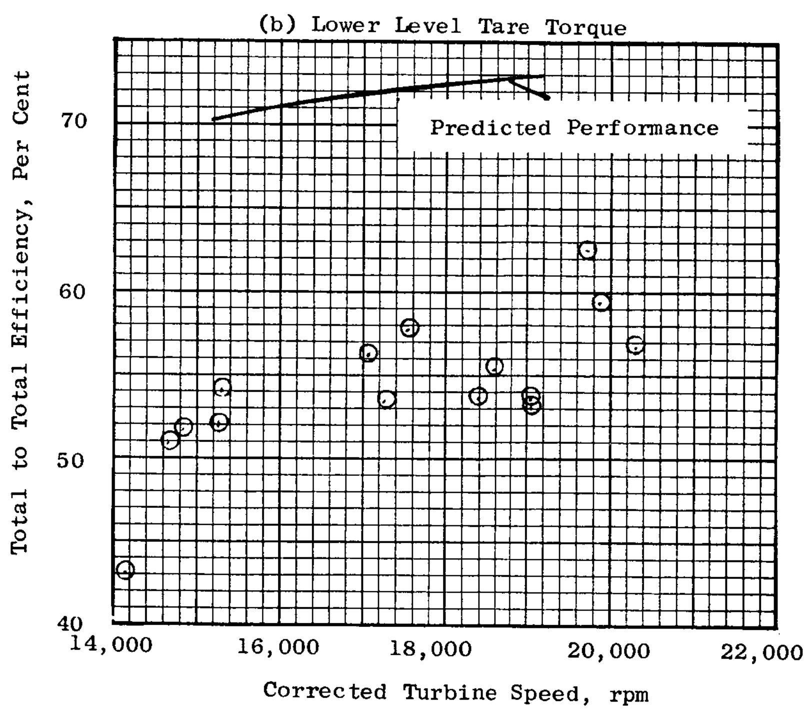


Figure 53. Variation of Turbine Efficiency with Rotative Speed for 1550°F Inlet Temperature, Zero Spray Flow, Total to Total Pressure Ratio, 3.0 ± 0.1.

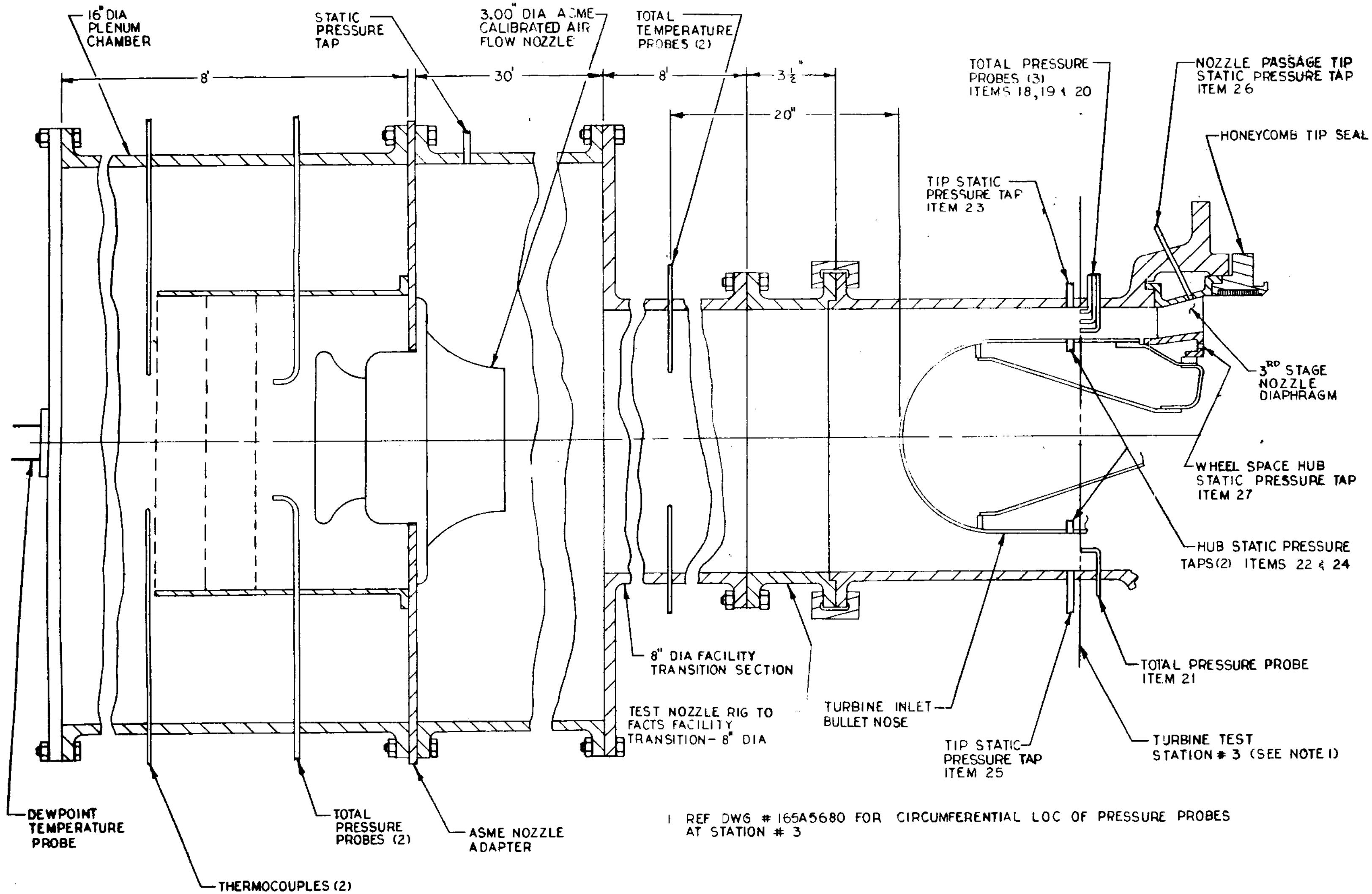
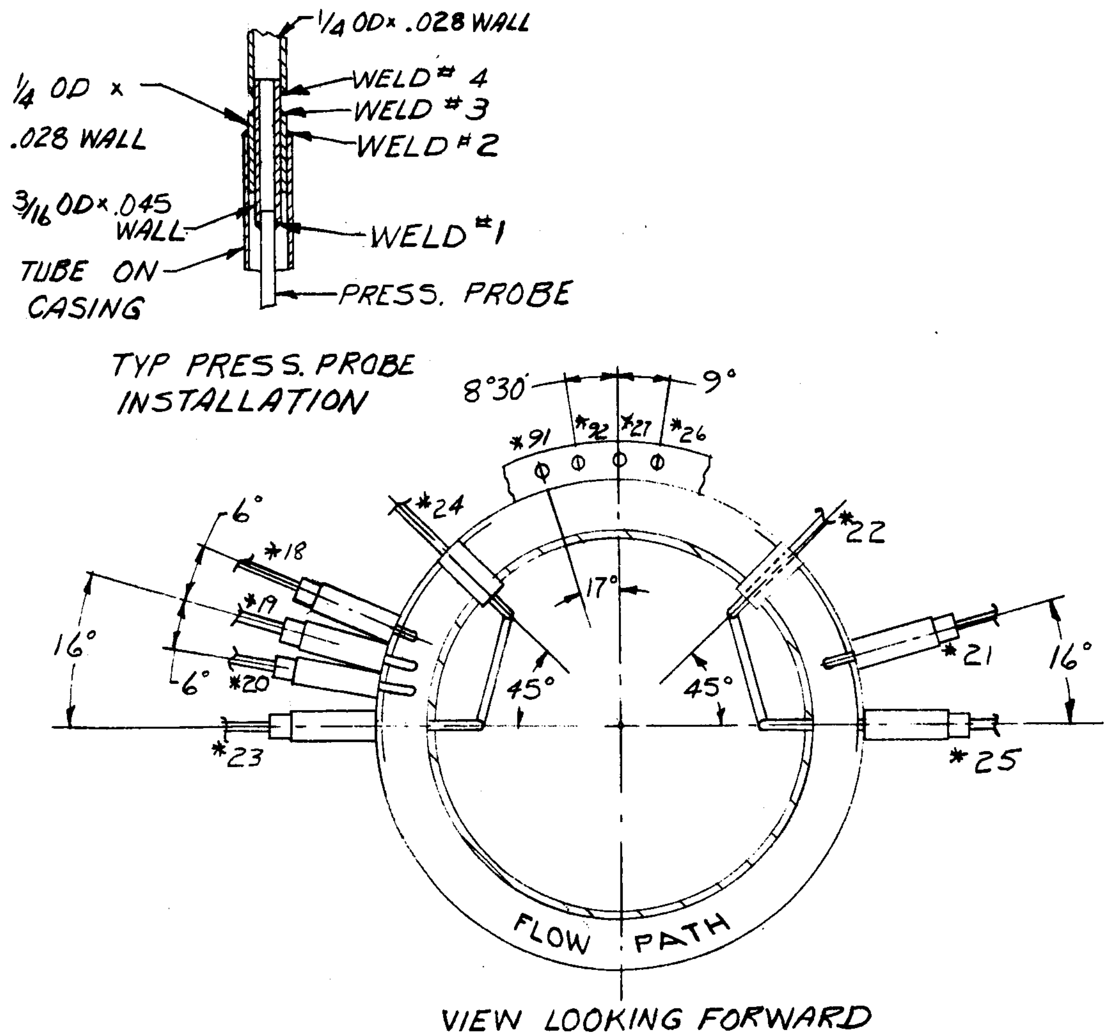


Figure 54 Bullet Nose Annulus Air Calibration Test Rig Schematic.



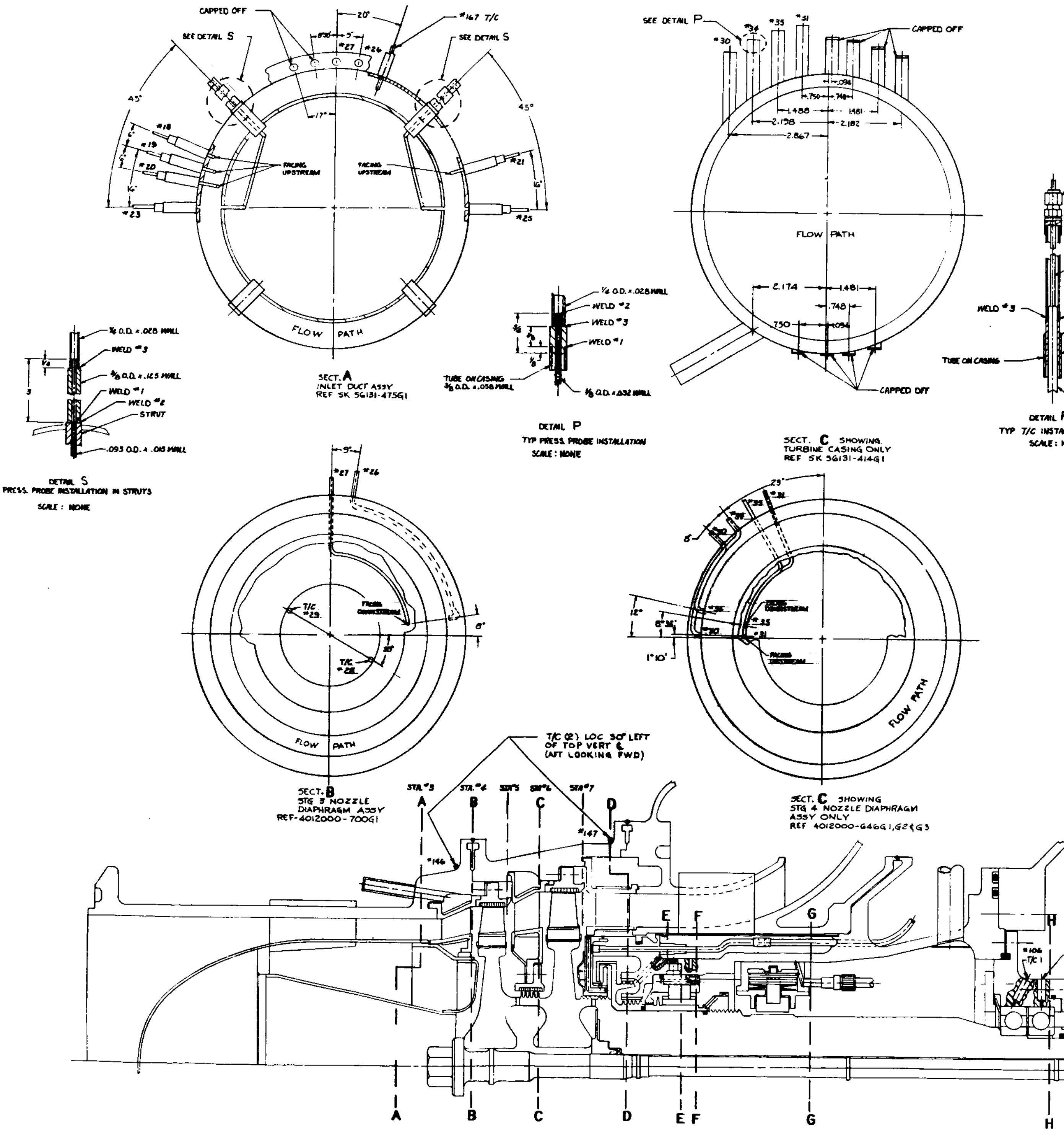
ALL NOS. MARKED * REFER TO ITEM NOS. OF POTASSIUM TURBINE TEST PLAN REV #1 DATED 4-20-64

REF SK56131-475G1

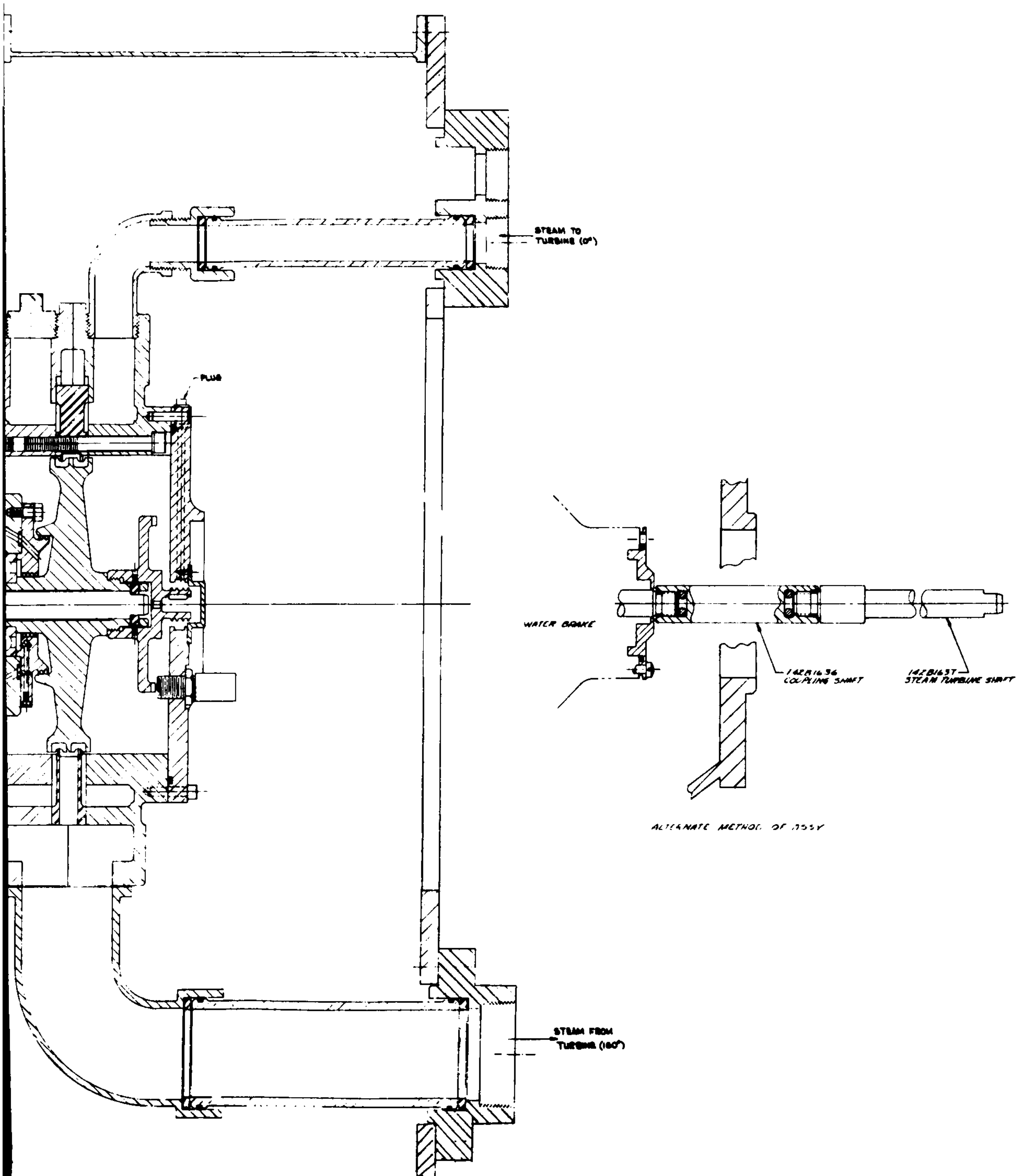
TURBINE TEST STA. #3

Figure 55 **First Stage Nozzle Diaphragm Inlet Instrumentation.**

4


CAPPED OFF
SEE DETAIL S
#167 T/C
#27
#26
45°
#18
#19
#20
#21
#23
#25
FACING UPSTREAM
FLOW PATH
SECT. A
INLET DUCT ASSY
REF SK 56131-475G1
1/4 O.D. x .028 WALL
WELD #3
3/8 O.D. x .125 WALL
WELD #1
WELD #2
STRUT
.093 O.D. x .015 WALL
DETAIL S
PRESS. PROBE INSTALLATION IN STRUTS
SCALE: NONE
WELD #2
WELD #3
WELD #1
TUBE ON CASING
DETAIL P
TYP PRESS. PROBE INSTALLATION
SCALE: NONE
SEE DETAIL P
#30
#34
#35
#31
CAPPED OFF
FLOW PATH
SECT. C SHOWING
TURBINE CASING ONLY
REF SK 56131-414G1
WELD #3
TUBE ON CASING
T/C #29
T/C #28
FACING DOWNSTREAM
FLOW PATH
SECT. B
STG 3 NOZZLE
DIAPHRAGM ASSY
REF-4012000-700G1
FLOW PATH
SECT. C SHOWING
STG 4 NOZZLE DIAPHRAGM
ASSY ONLY
REF 4012000-646G1, G2 & G3
T/C (2) LOC 30° LEFT
OF TOP VERT ℄
(AFT LOOKING FWD)
STA #3
STA #4
STA #5
STA #6
STA #7
#146
#147
A
B
C
D
E
F
G
H

3


PLUG
STEAM TO
TURBINE (0°)
WATER BRAKE
142B1636
COUPLING SHAFT
142B1637
STEAM TURBINE SHAFT
ALTERNATE METHOD OF ASSY
STEAM FROM
TURBINE (180°)

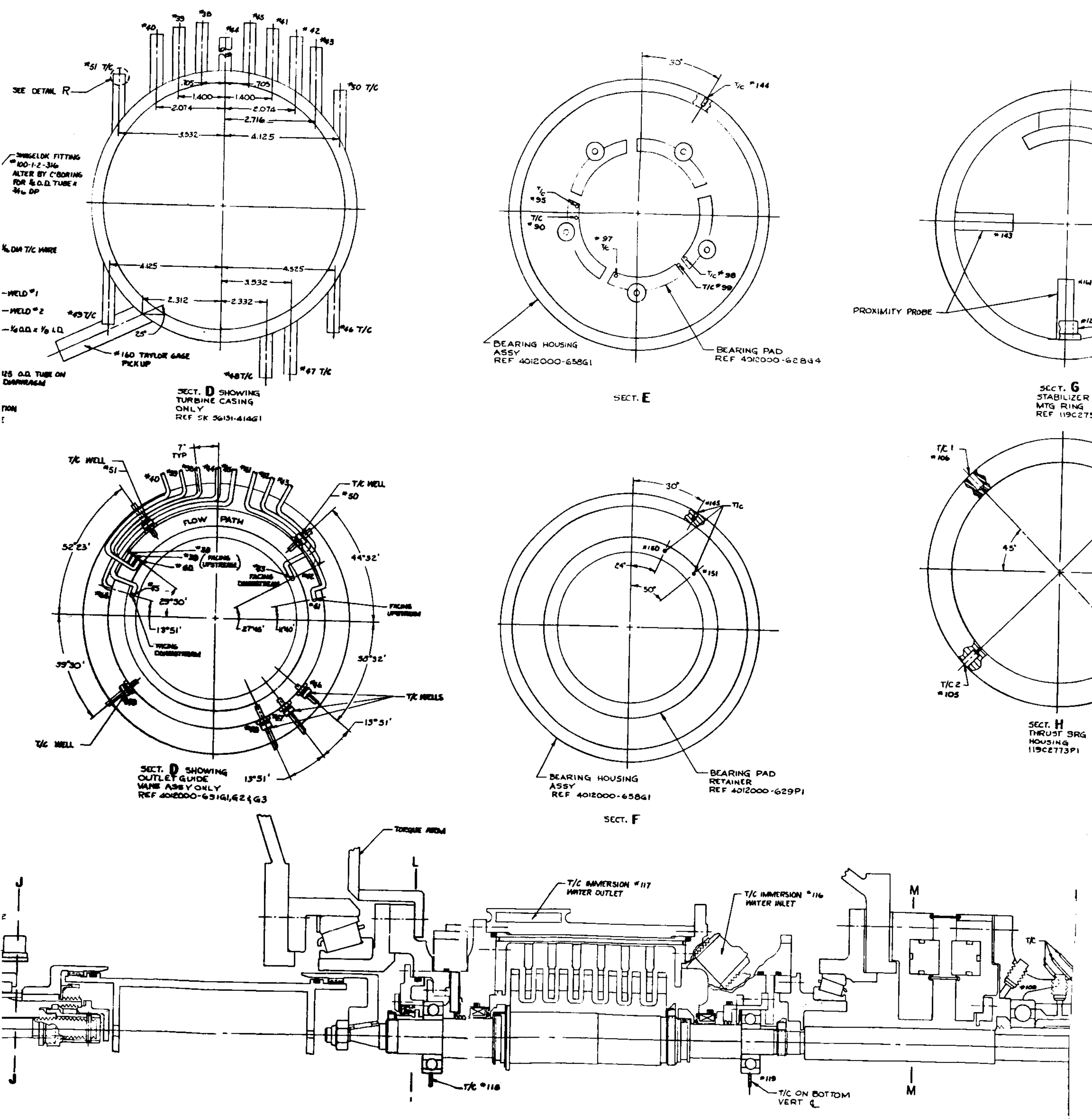
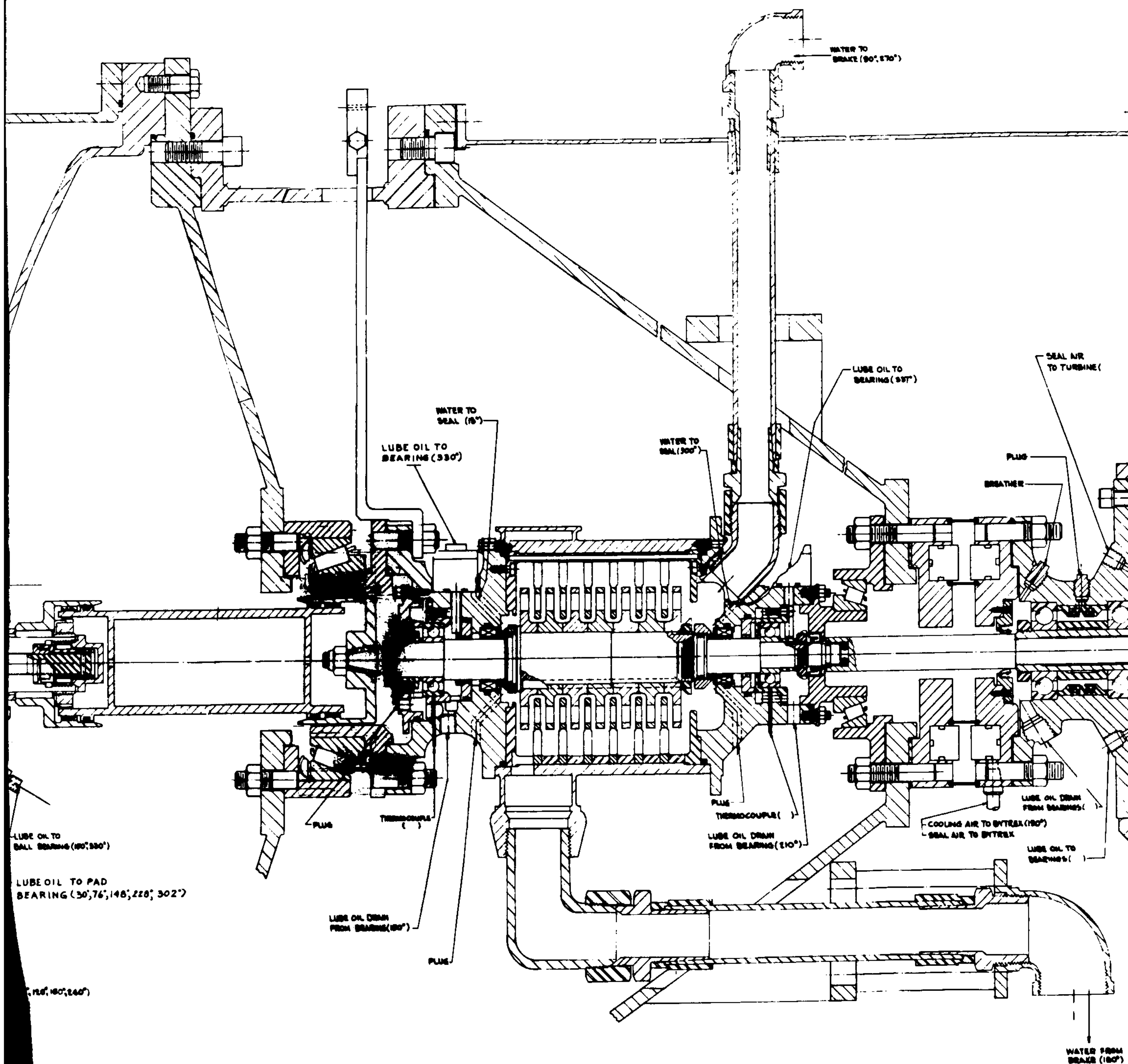
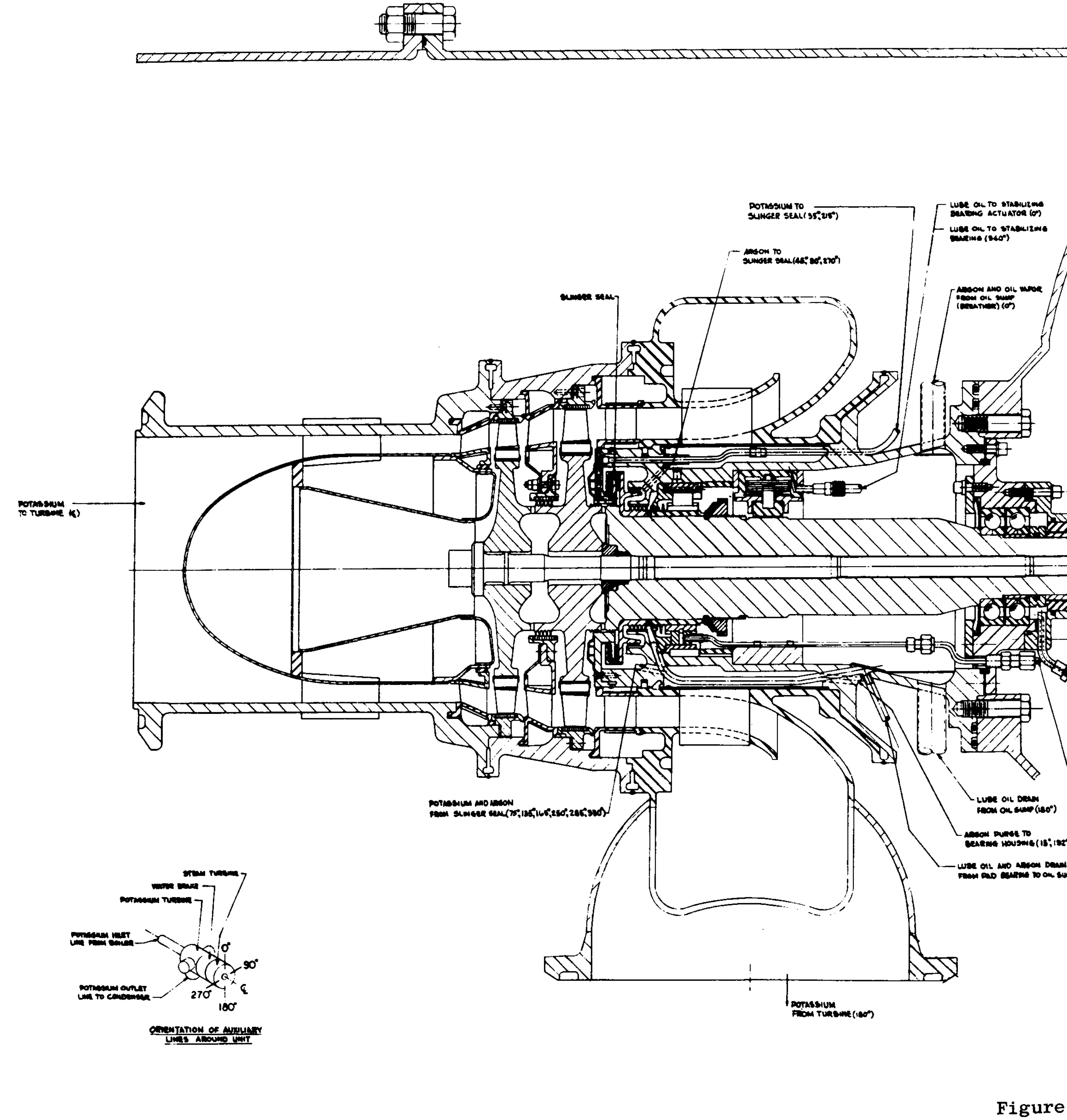


Figure 57. Instrumentation Drawing Potassium Turbine.

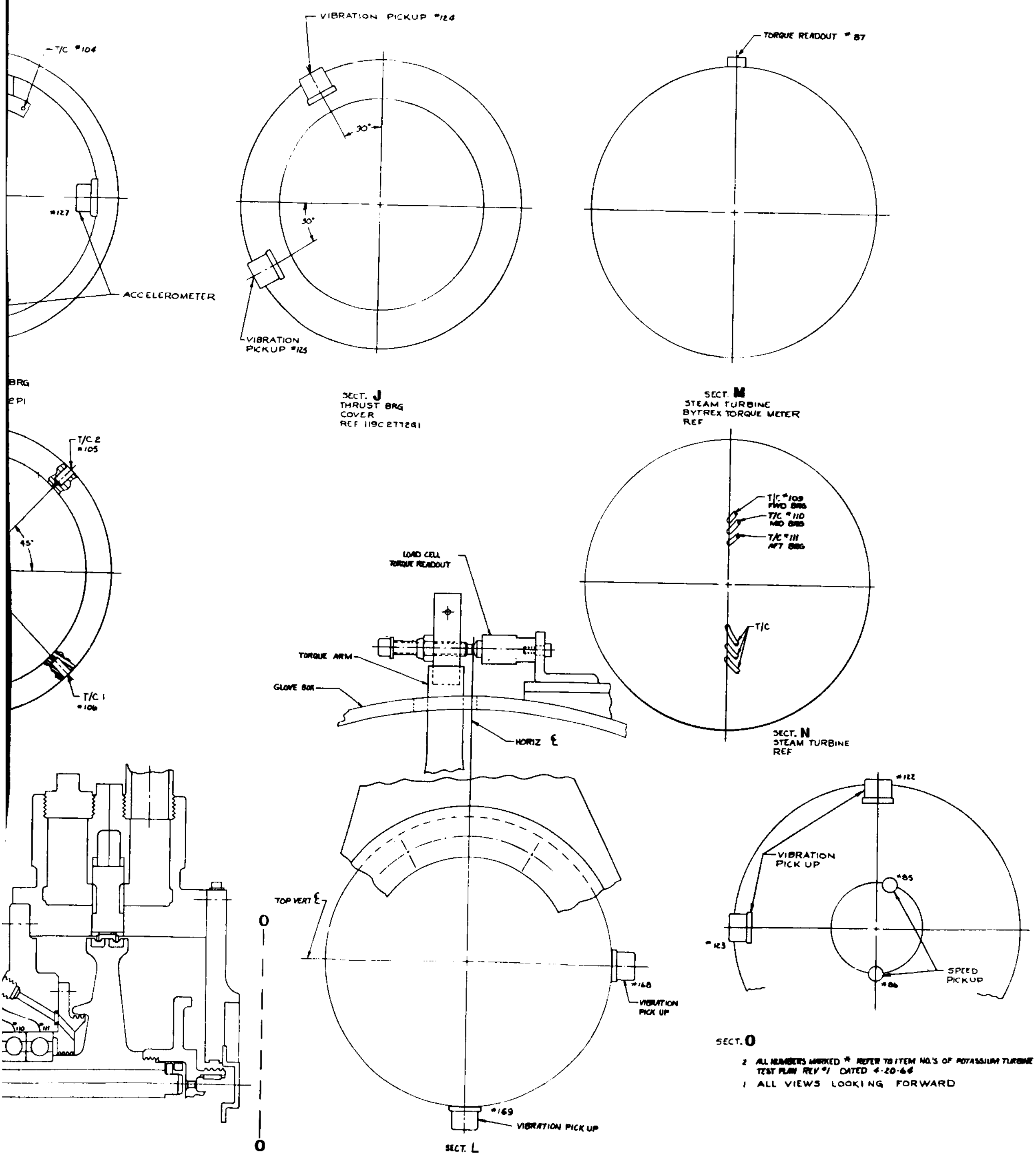


. Sectional View of Potassium Turbine Loading and Starting
System.


POTASSIUM TO
SLINGER SEAL (35°, 215°)
LUBE OIL TO STABILIZING
BEARING ACTUATOR (0°)
LUBE OIL TO STABILIZING
BEARING (340°)
ARGON TO
SLINGER SEAL (45°, 90°, 270°)
ARGON AND OIL VAPOR
FROM OIL SUMP
(BREATHER) (0°)
SLINGER SEAL
POTASSIUM
TO TURBINE
POTASSIUM AND ARGON
FROM SLINGER SEAL (75°, 135°, 165°, 250°, 285°, 330°)
LUBE OIL DRAIN
FROM OIL SUMP (180°)
ARGON PURGE TO
BEARING HOUSING
LUBE OIL AND ARGON DRAIN
POTASSIUM
FROM TURBINE (180°)
STEAM TURBINE
WATER BRAKE
POTASSIUM TURBINE
POTASSIUM INLET
LINE FROM BOILER
POTASSIUM OUTLET
LINE TO CONDENSER
0°
90°
270°
180°
ORIENTATION OF AUXILIARY
LINES AROUND UNIT

Figure

6



2 ALL NUMBERS MARKED * REFER TO ITEM NO.'S OF POTASSIUM TURBINE TEST PLAN REV #1 DATED 4-20-64

1 ALL VIEWS LOOKING FORWARD

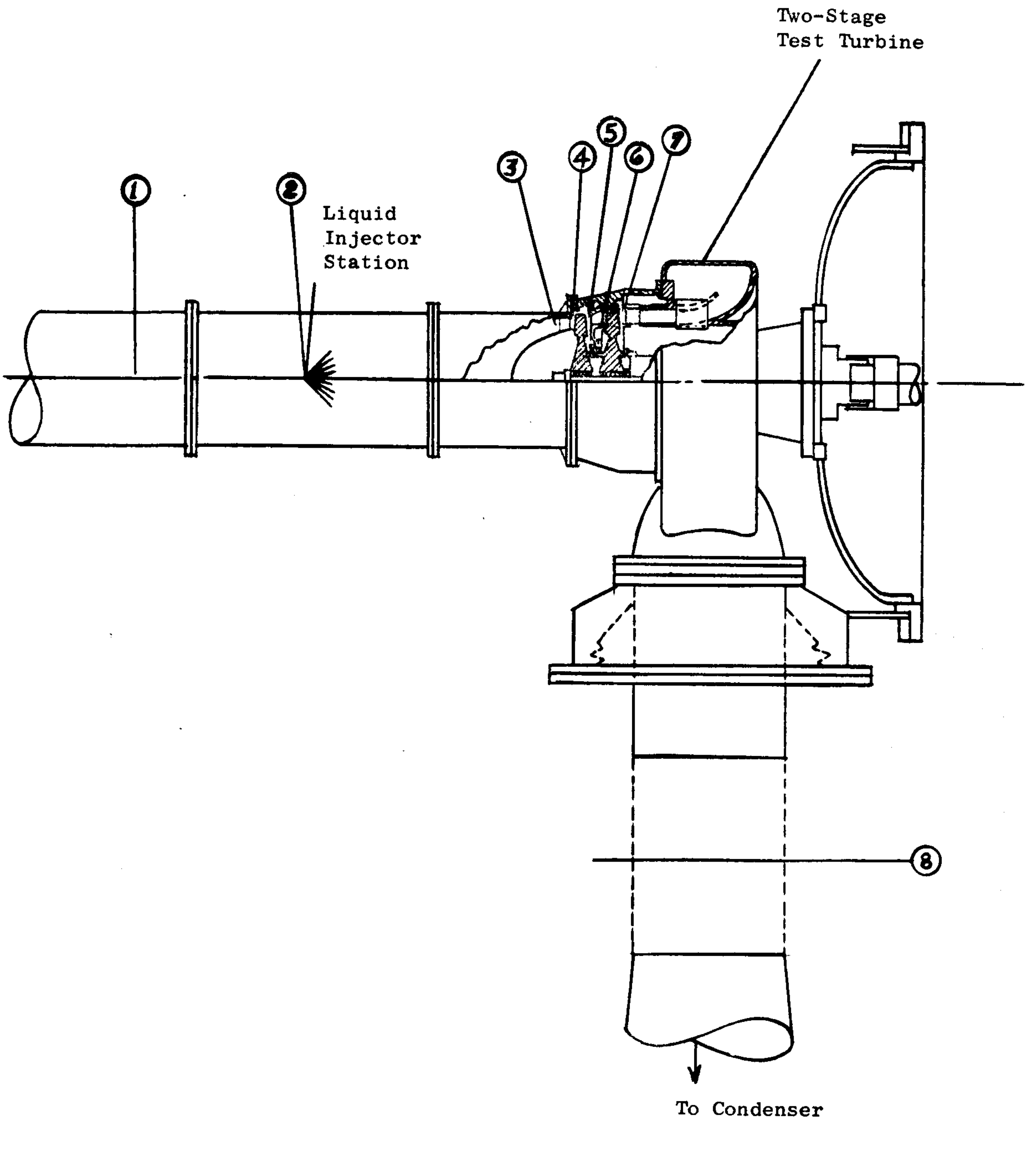


Figure 58 **Instrumentation Stations**

Note: All total pressure and total temperature sensors arranged in equal area annuli.

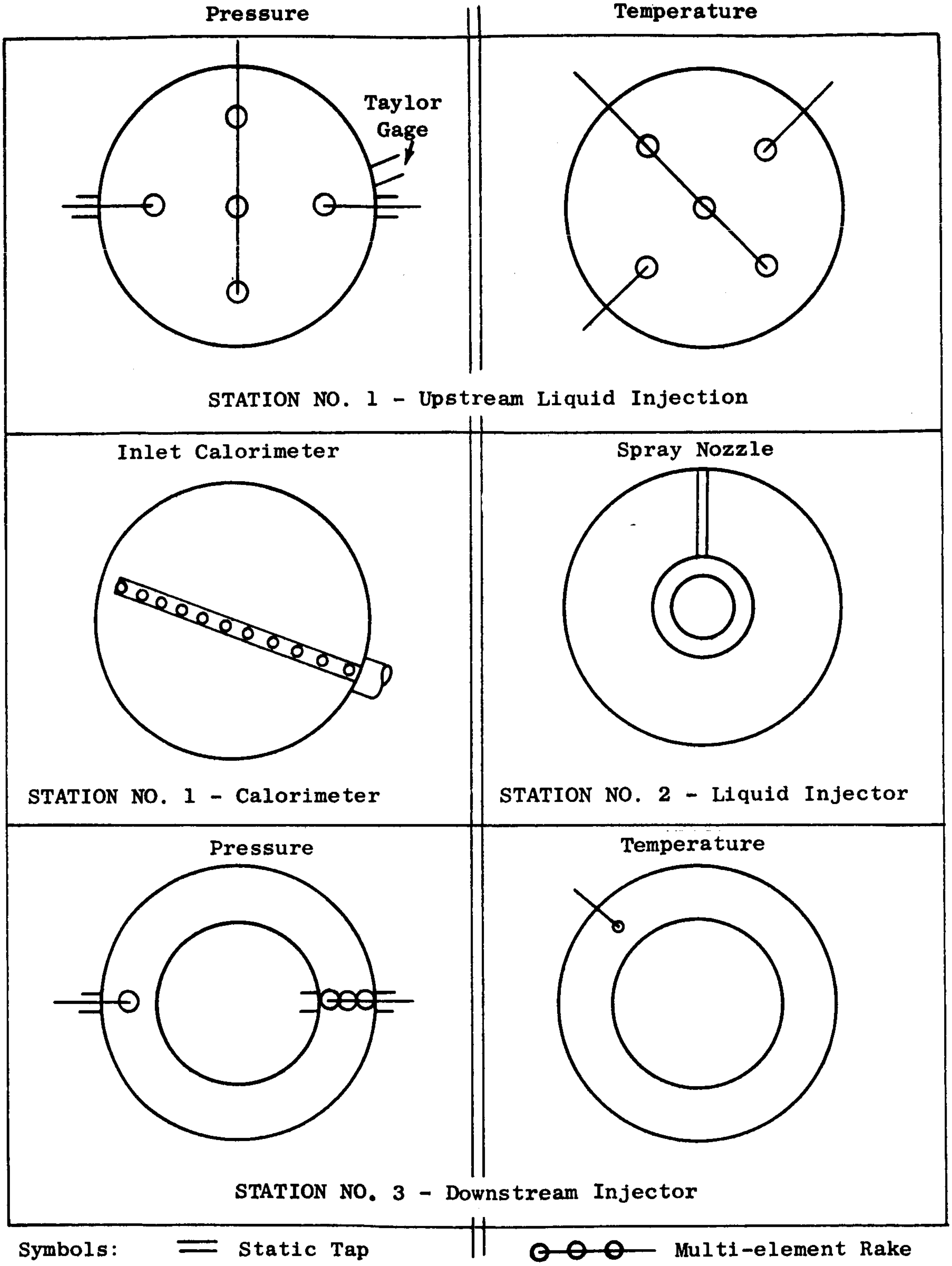


Figure 59 Potassium Test Turbine Instrumentation Location

Note: All total pressure and total temperature sensors arranged in equal area annuli.

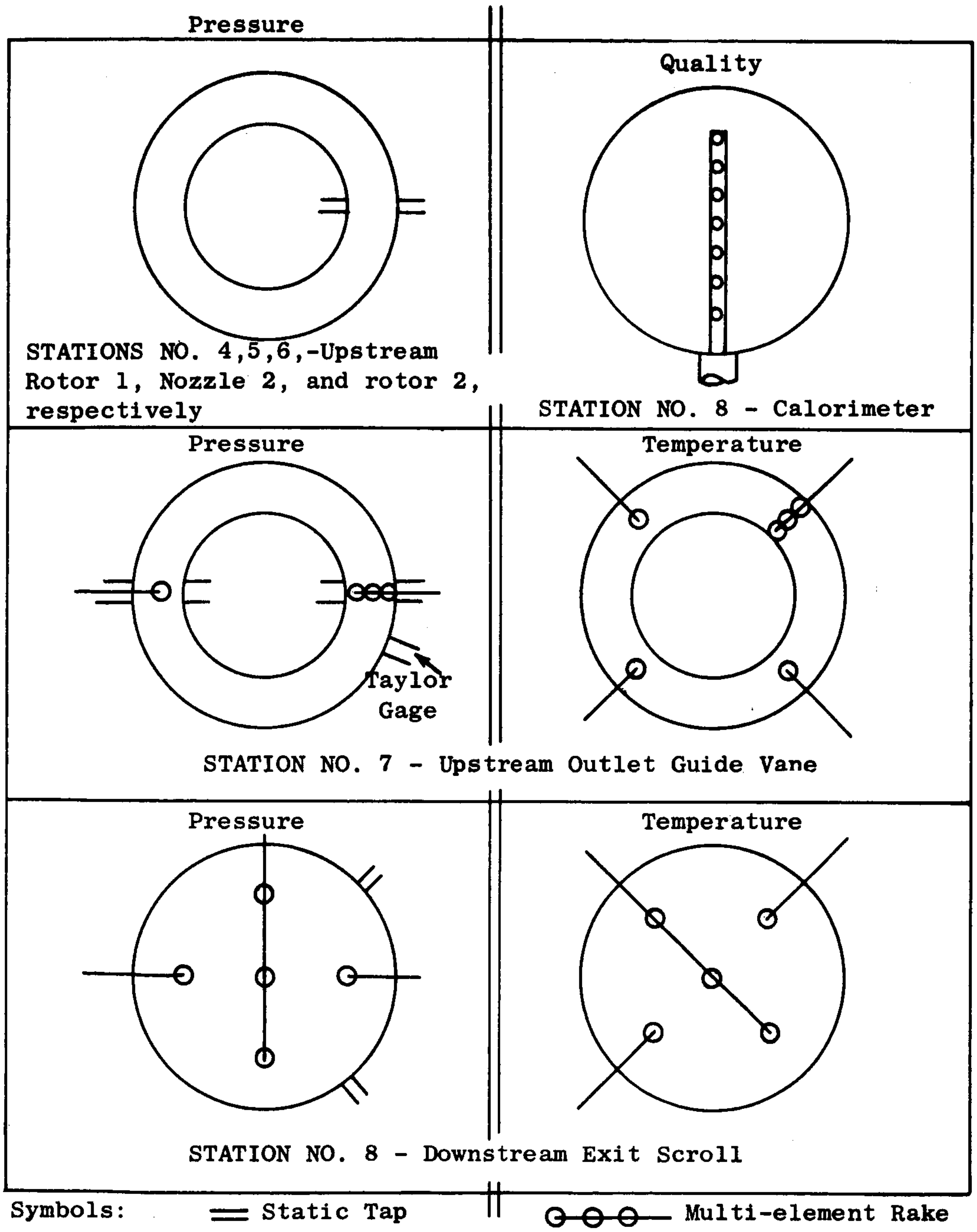


Figure 60 Potassium Test Turbine Instrumentation Location

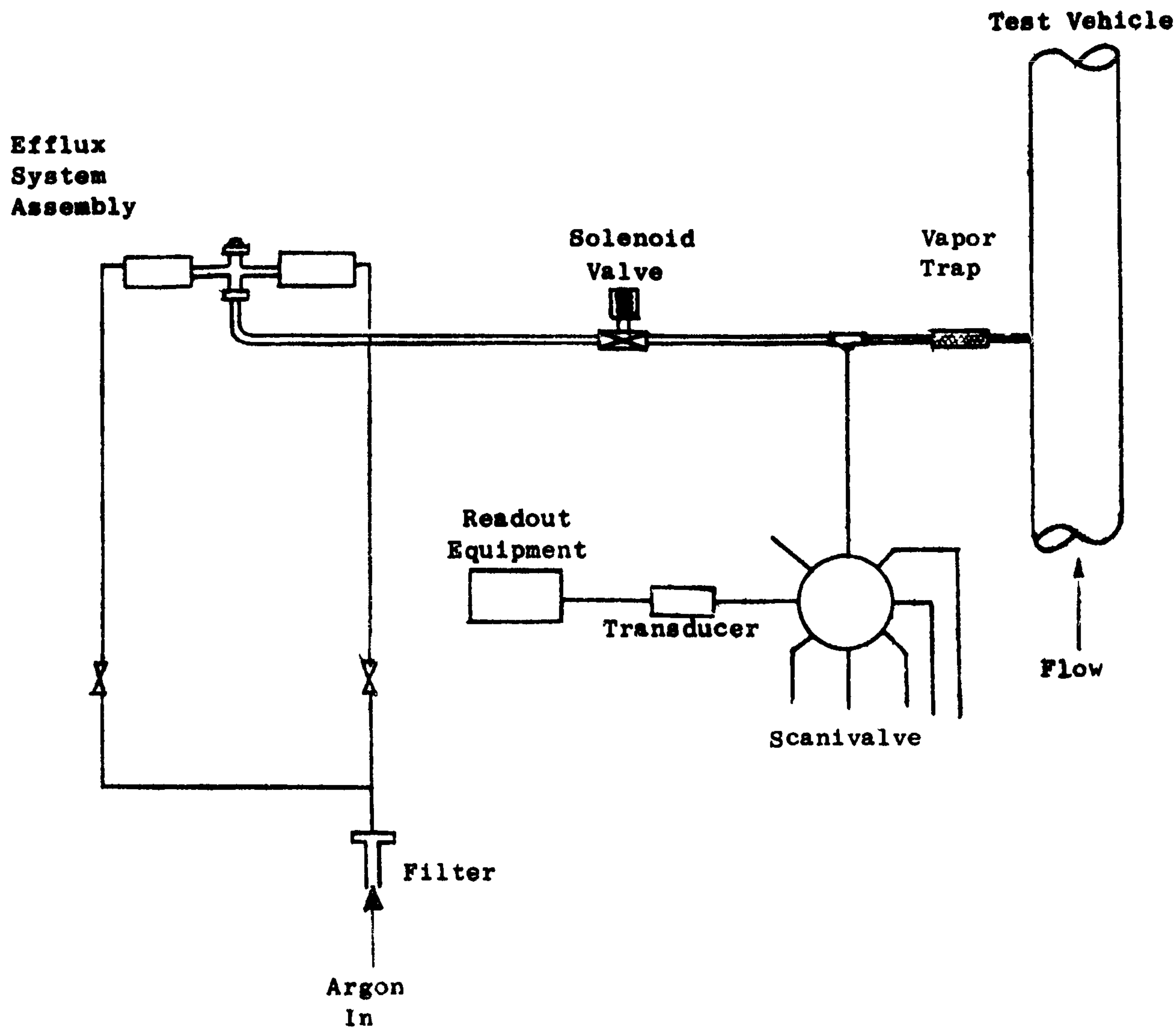


Figure 61. Schematic Diagram of Efflux Pressure Measuring Device.

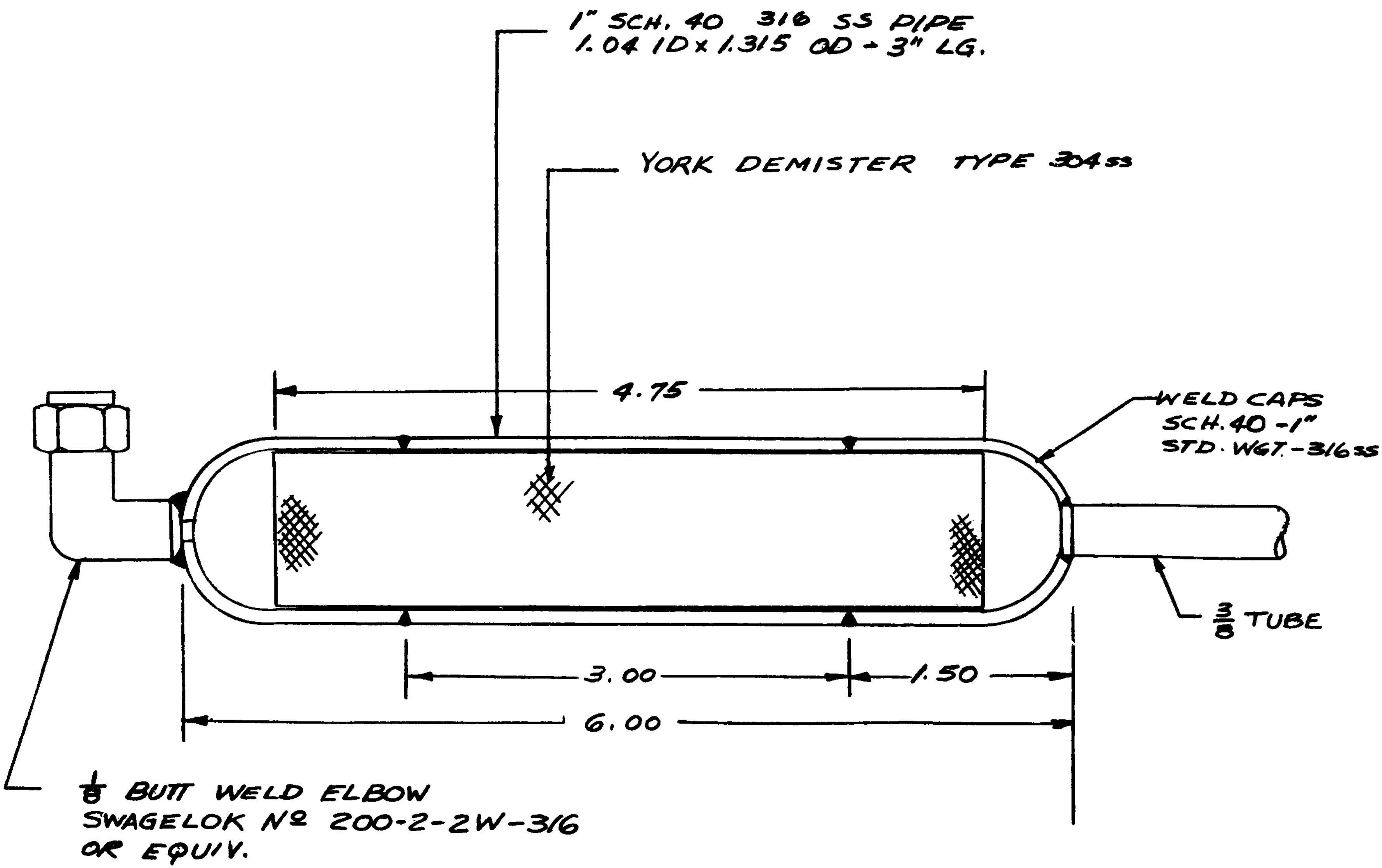


Figure 62. Efflux Vapor Trap.

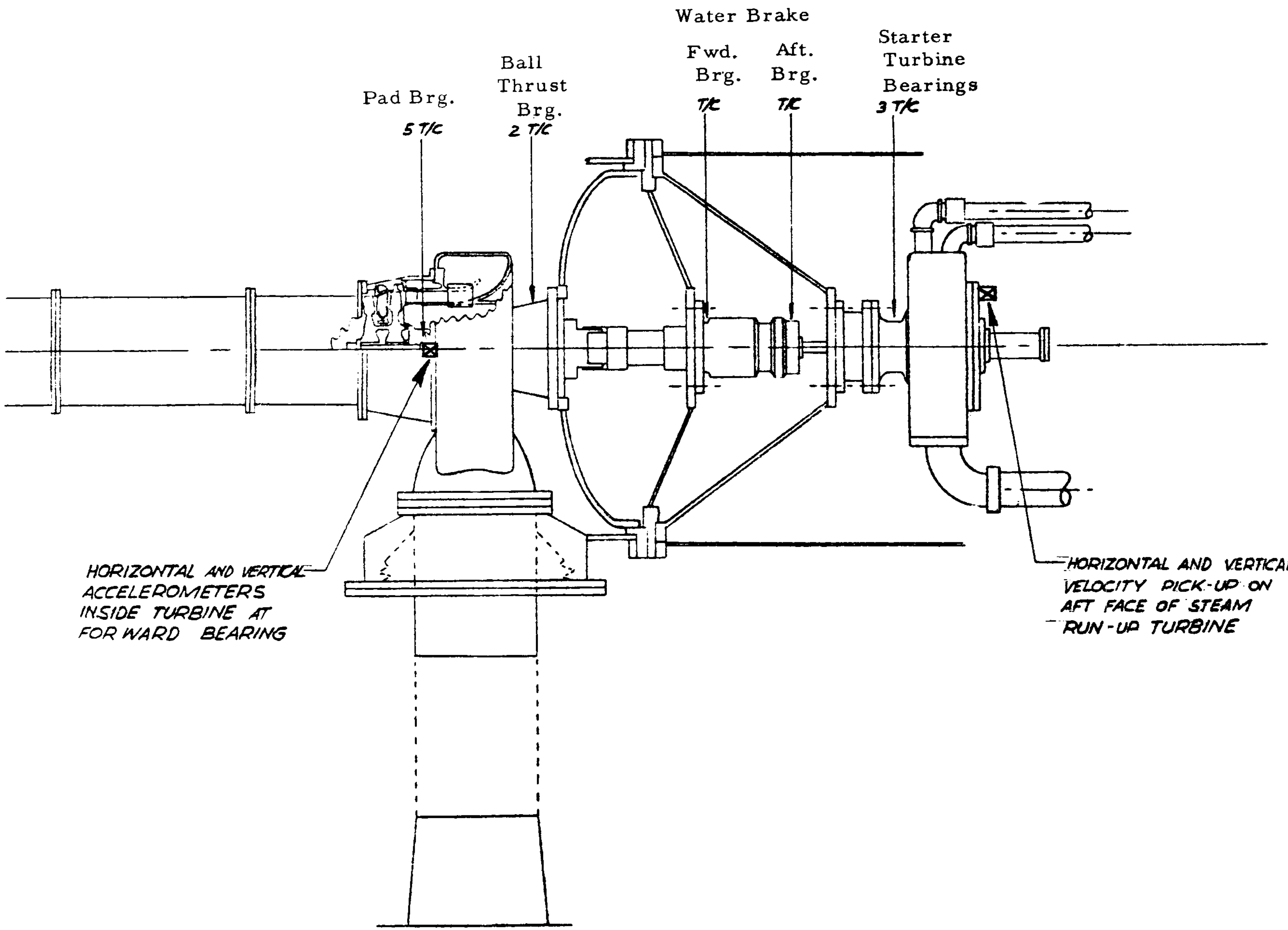


Figure 63. Instrumentation in the Test Rig System.

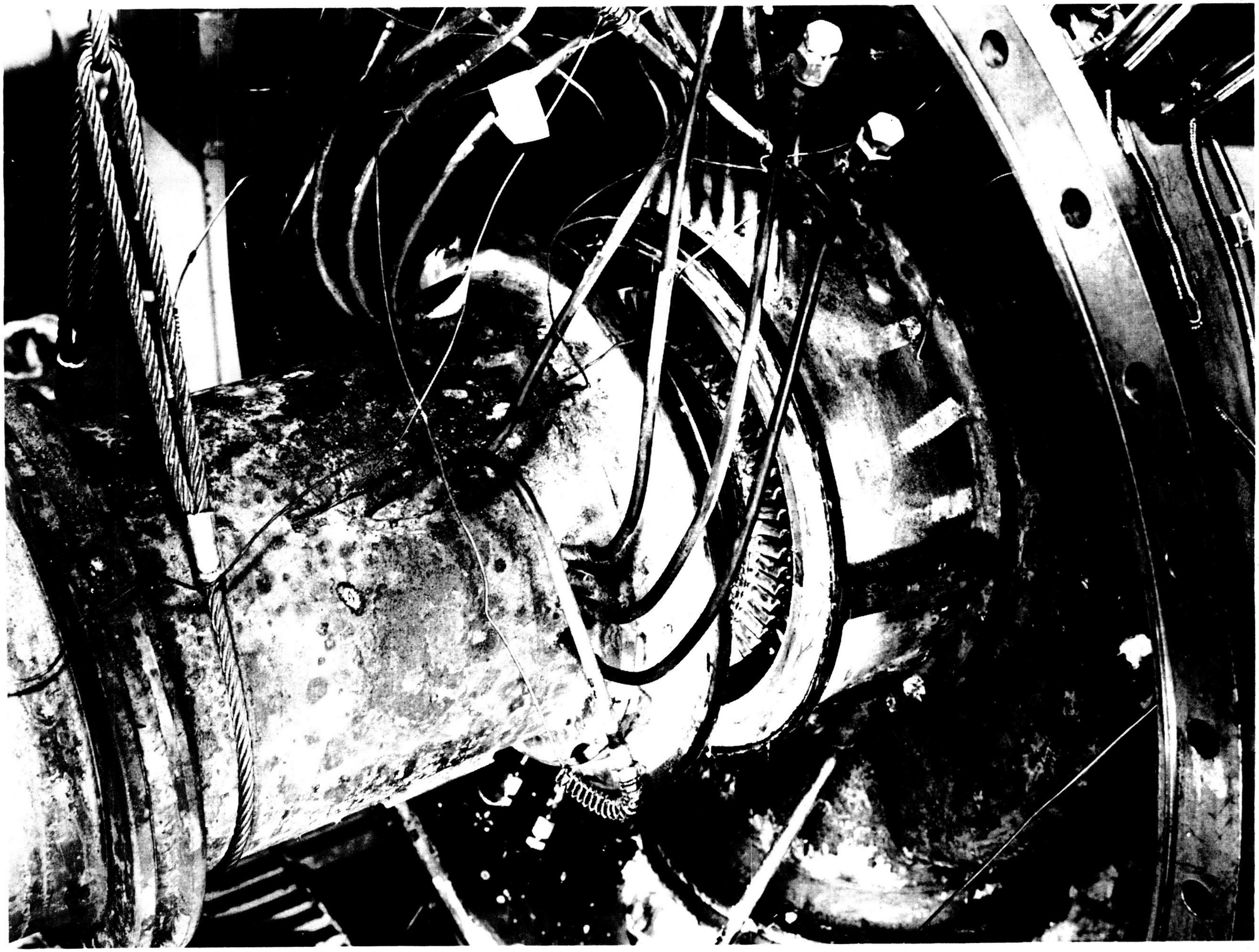


Figure 64. Turbine Following Opening of Forward Flange for Inspection.

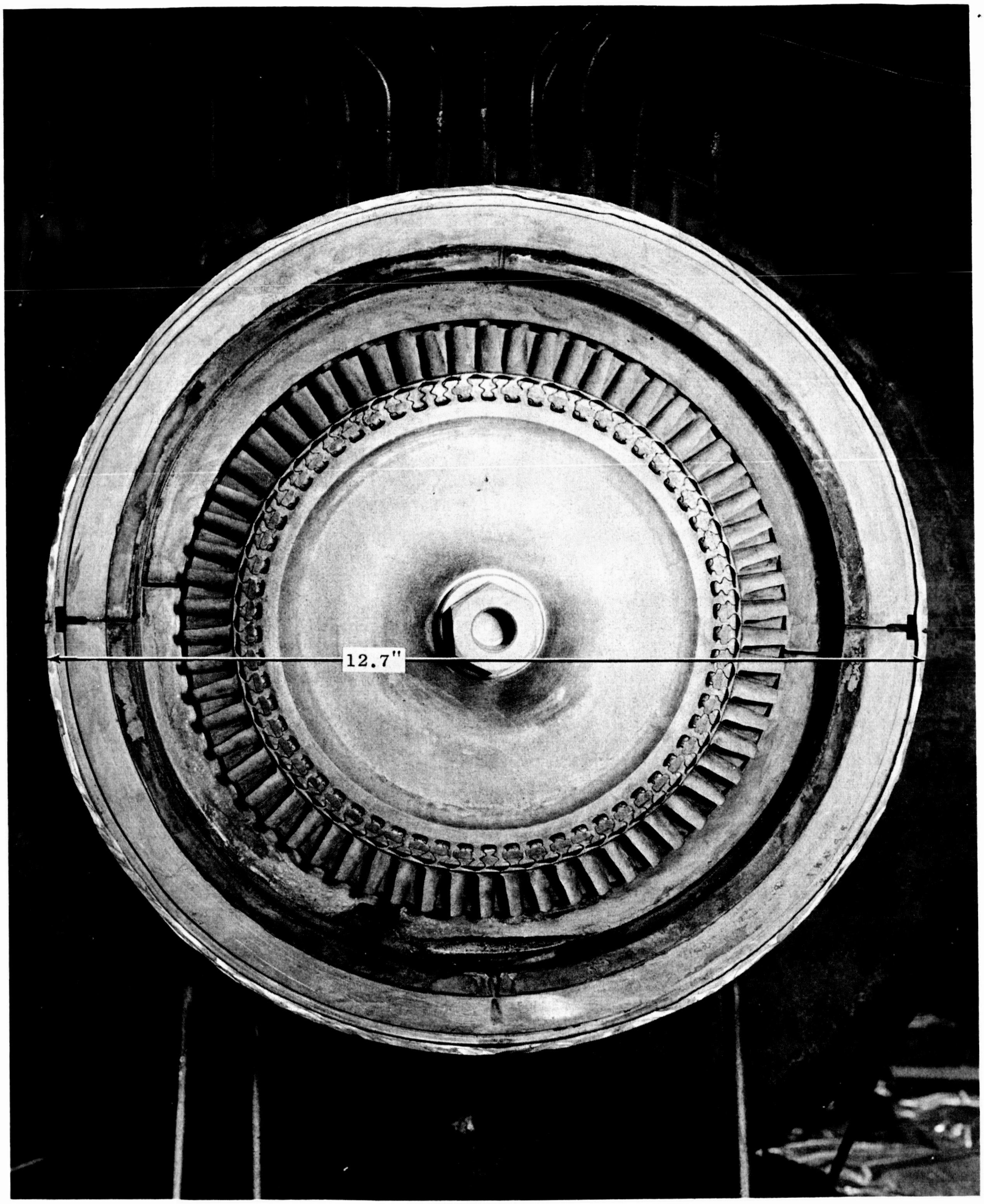


Figure 65. Turbine First Stage Rotor Following Removal of Inlet Duct.

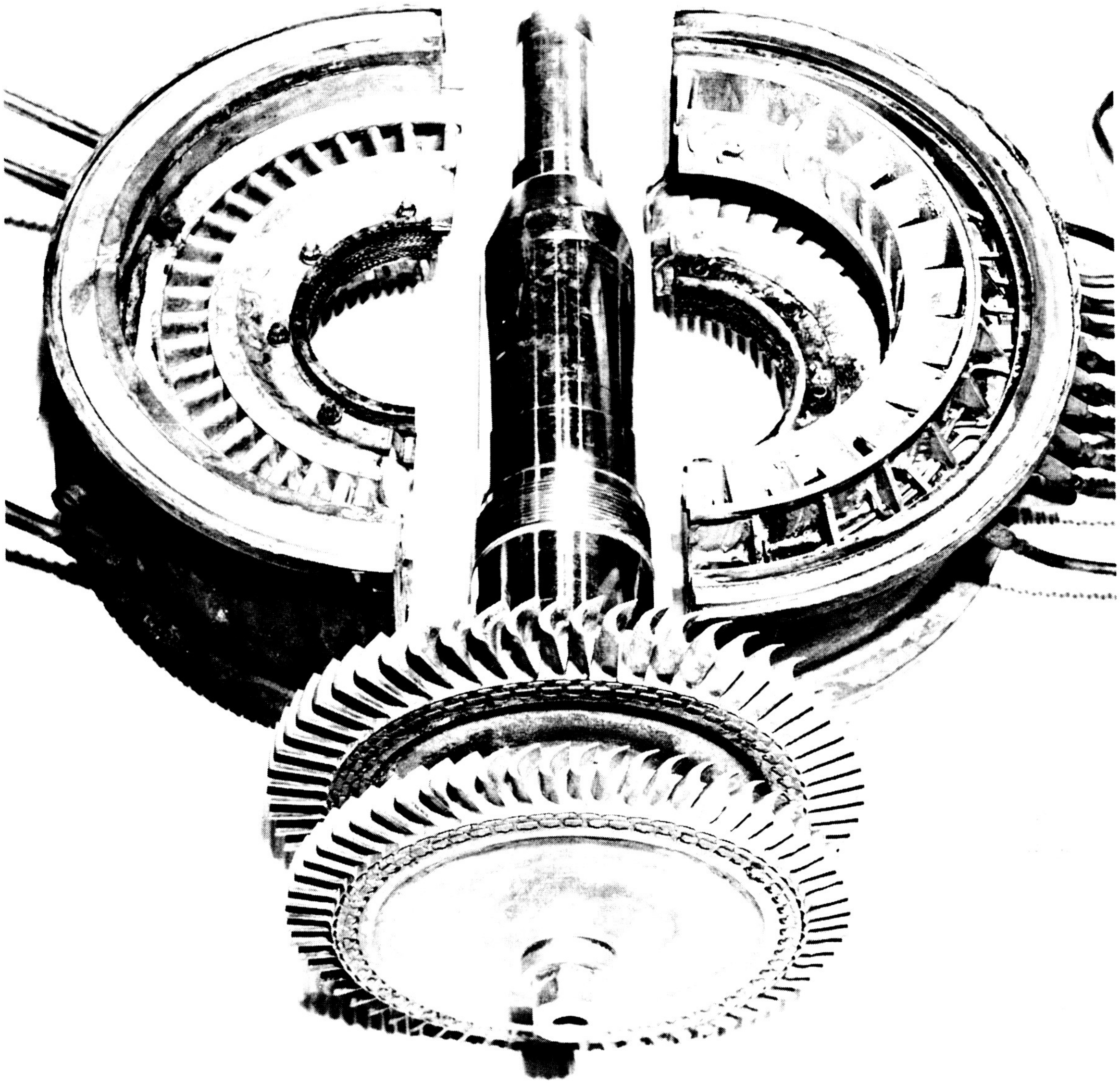


Figure 66. Rotor and Stator Following Removal From Test Facility

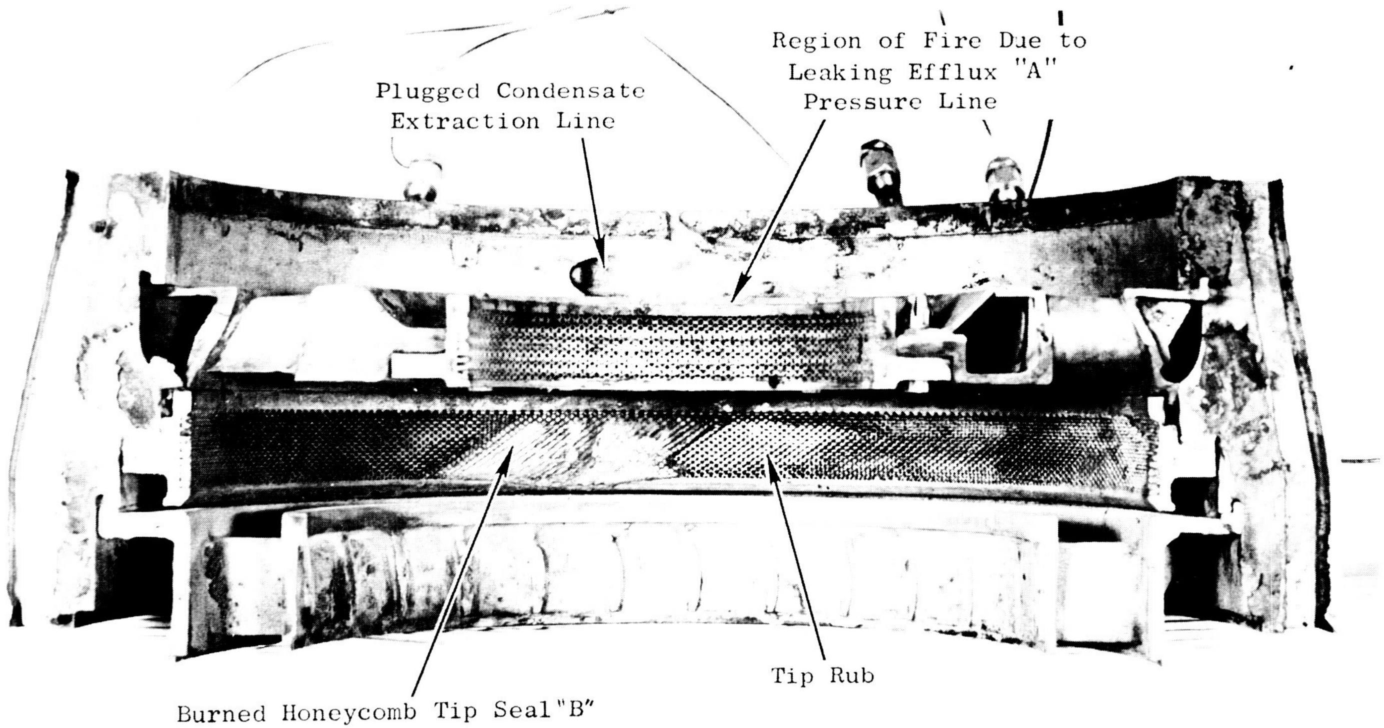


Figure 67. Fire Damage in Stage 2 Tip Seal

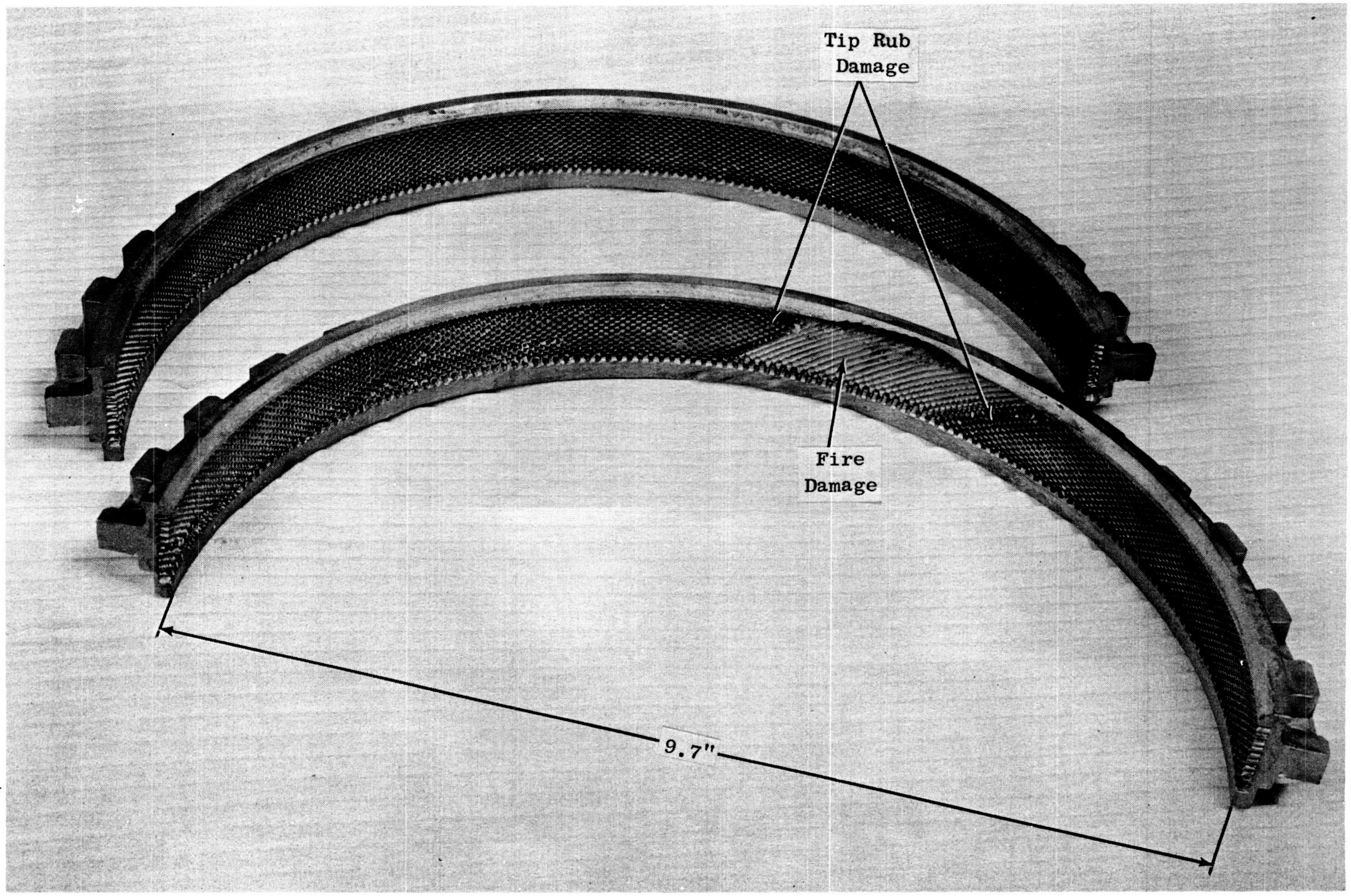


Figure 68. Second Stage Honeycomb Tip Seal Following Casing Disassembly.

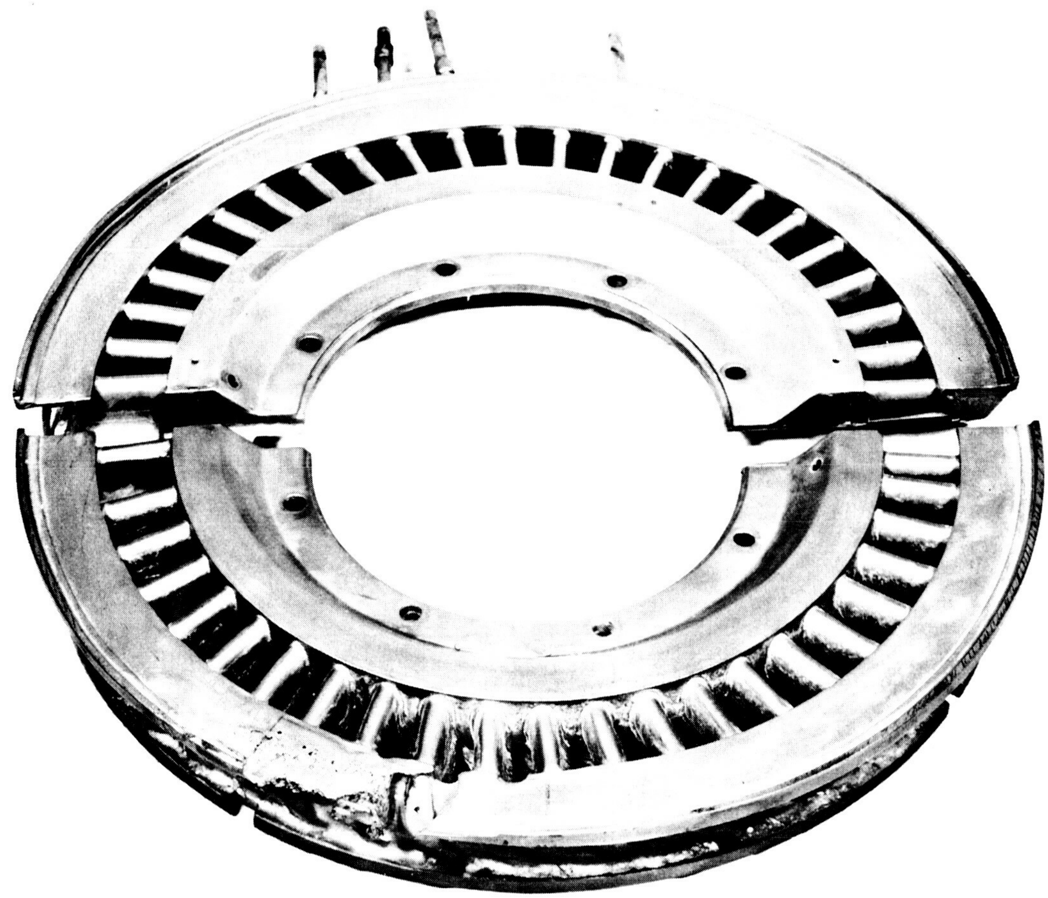


Figure 69. Stage 2 Nozzle Diaphragm After Removal From Casing

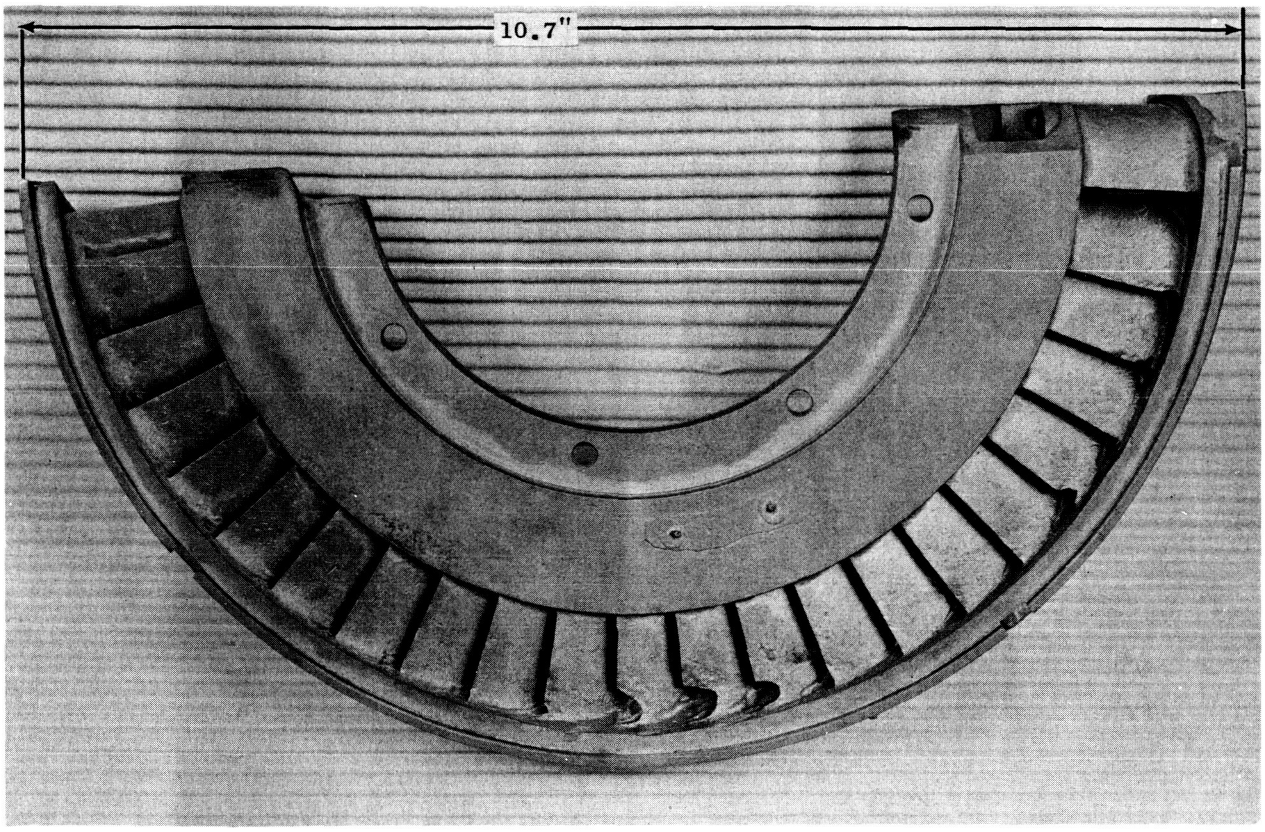


Figure 70. Fire Damage to Stage 2 Nozzle Diaphragm Vanes.

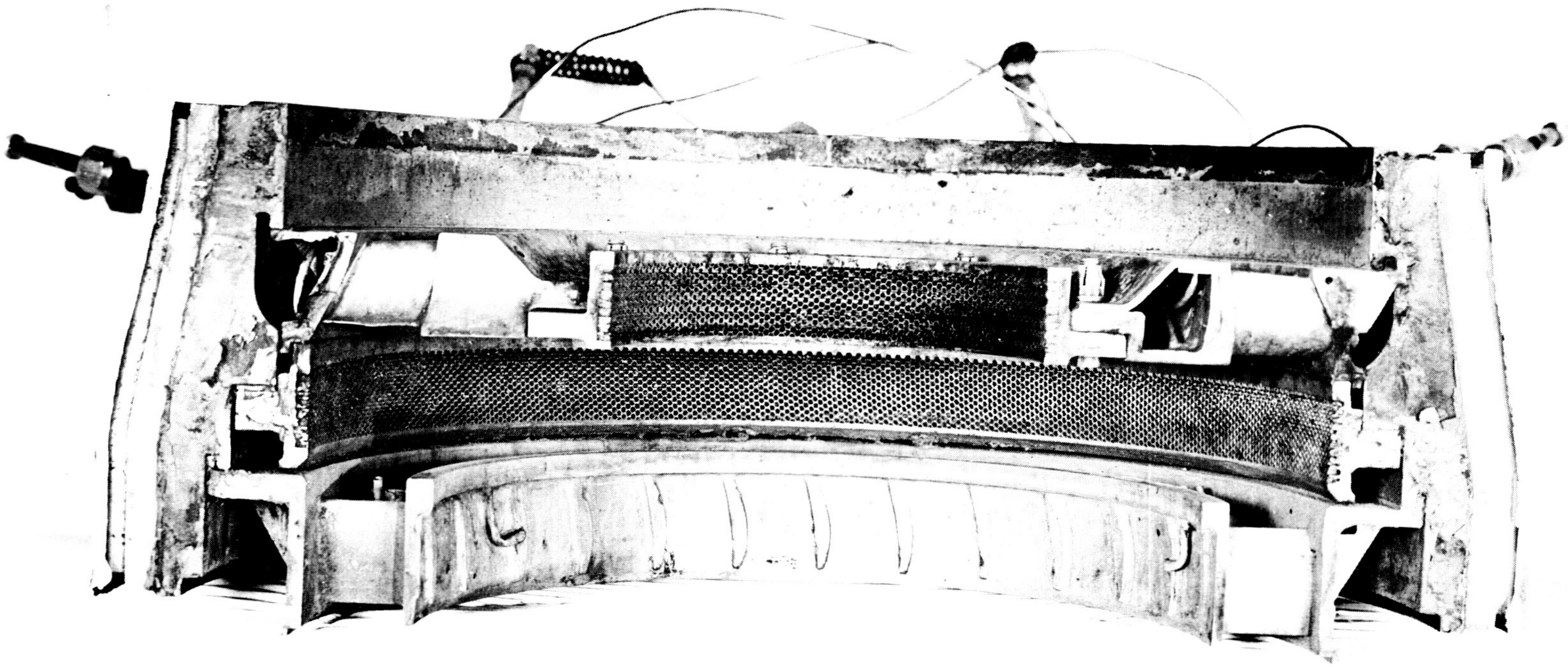


Figure 71. Upper Casing Half.

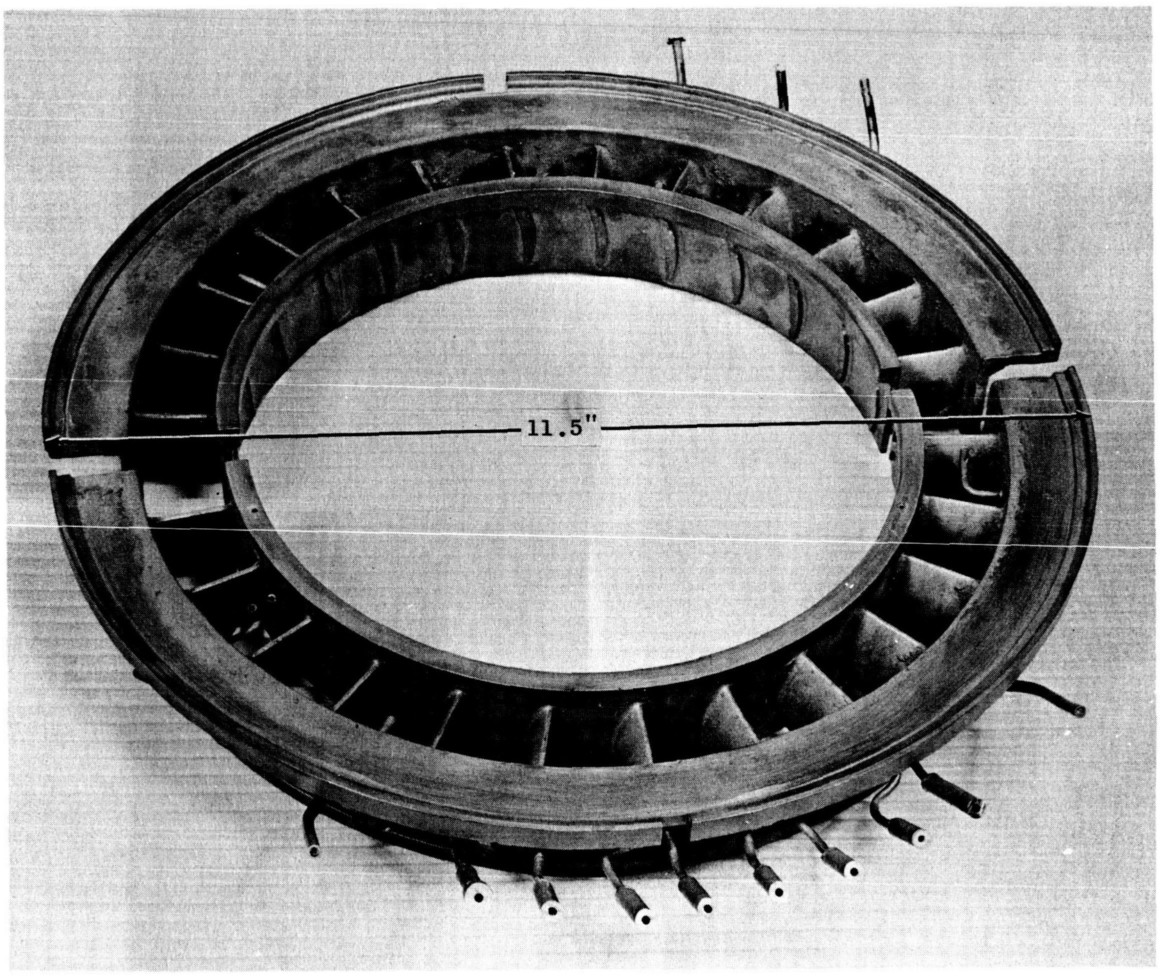


Figure 72. Outlet Guide Vane After Removal From Casing.

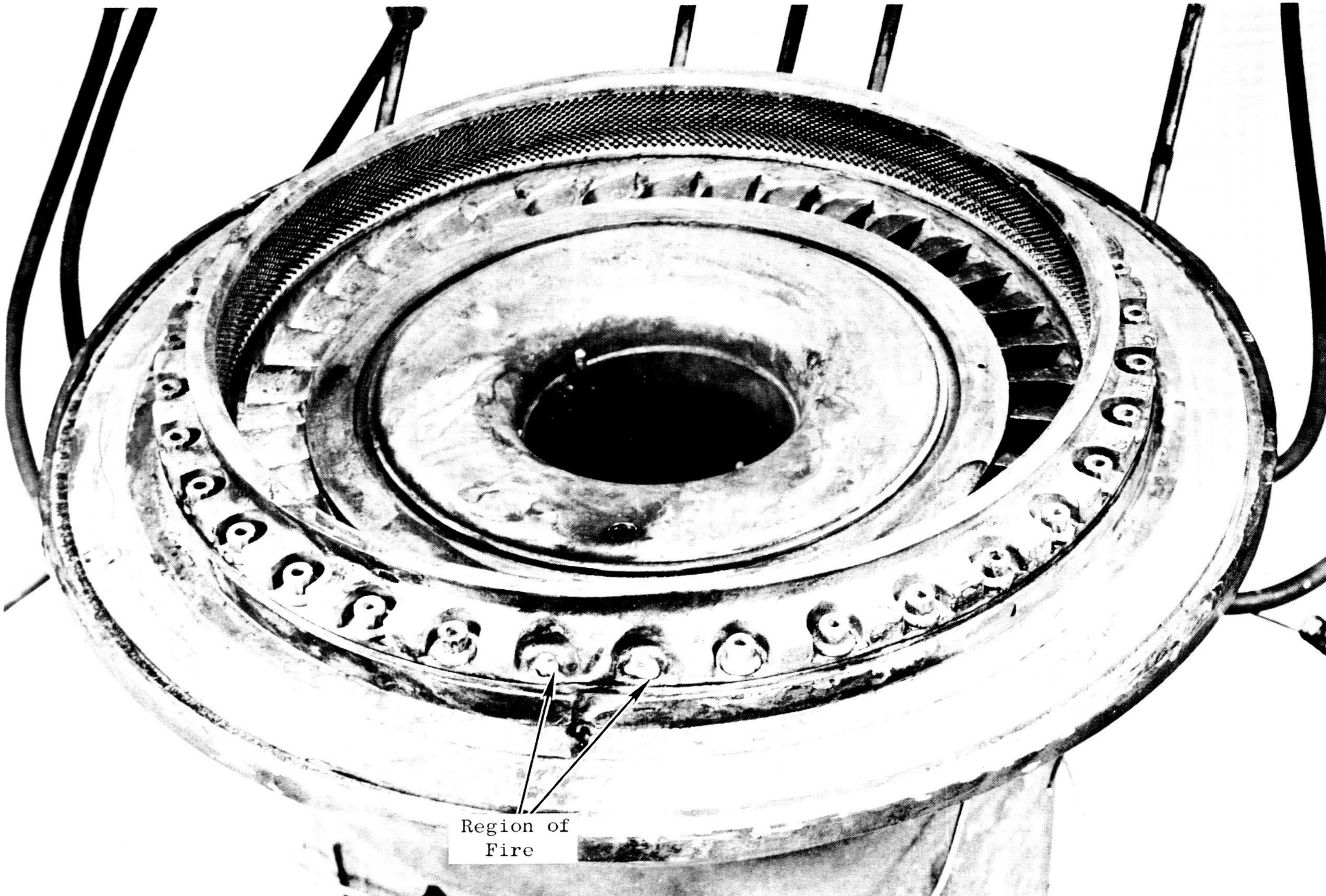


Figure 73. Region of Stage 1 Nozzle Diaphragm and Tip Seal

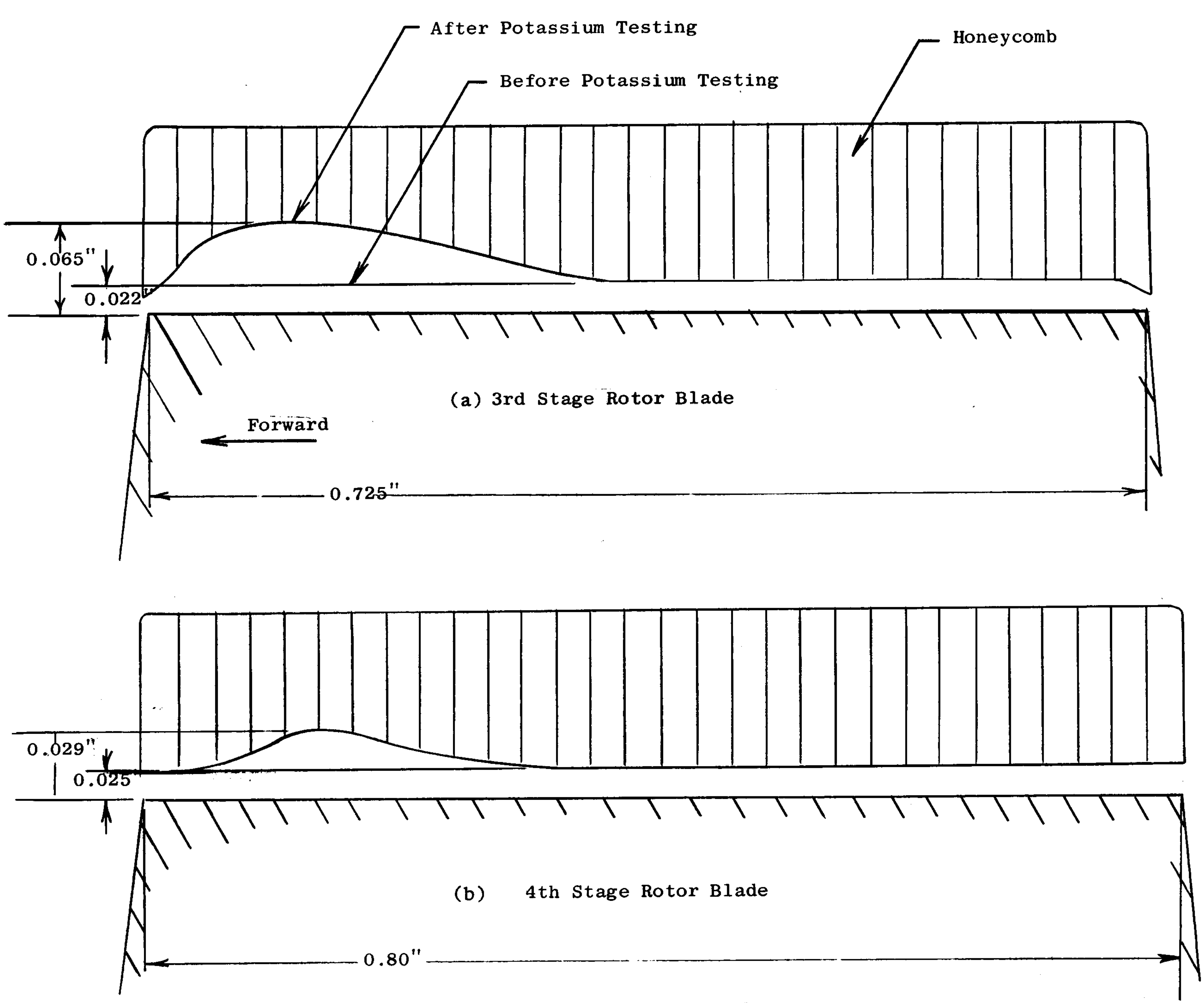


Figure 74 Seal Tip Clearance Change

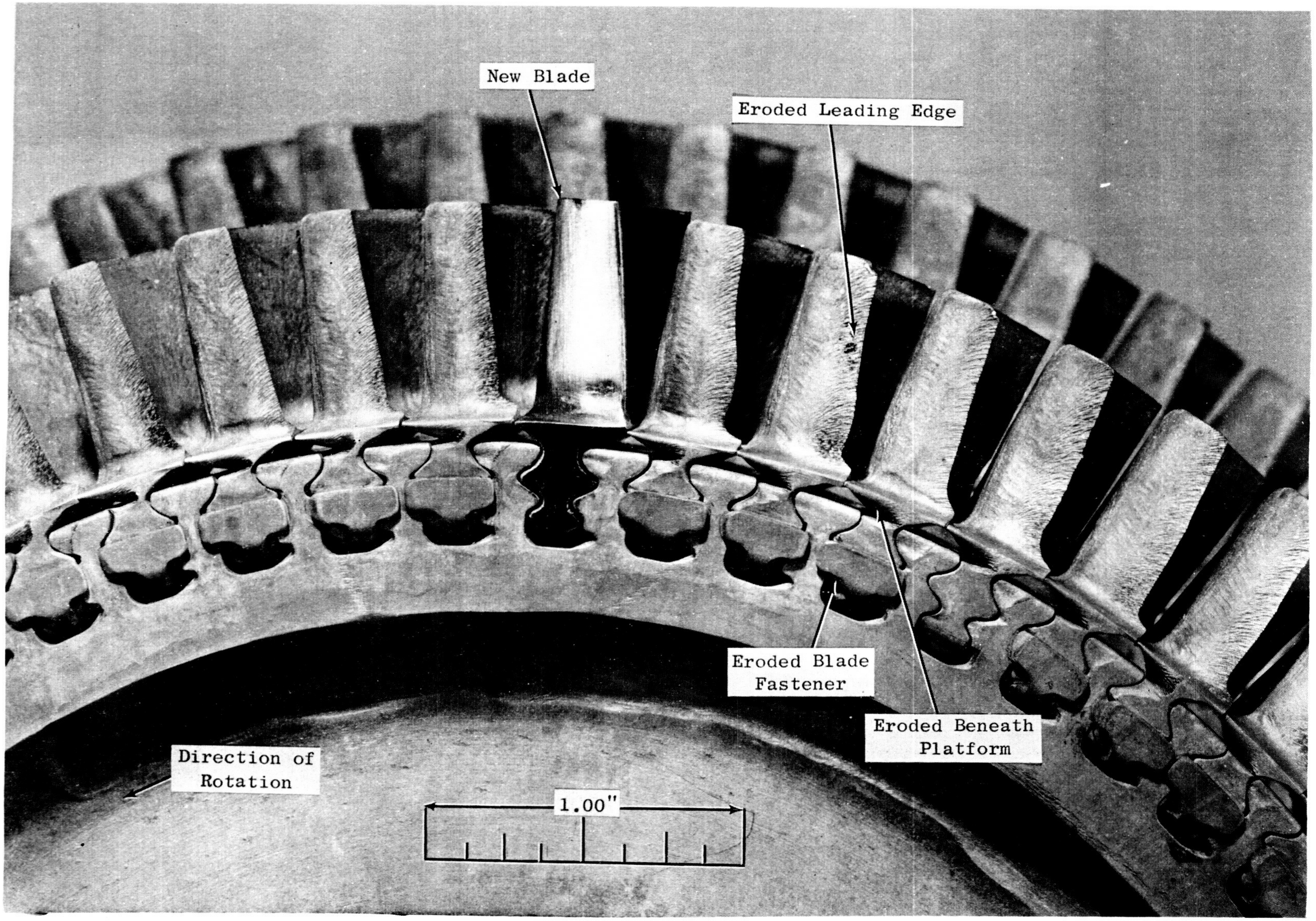
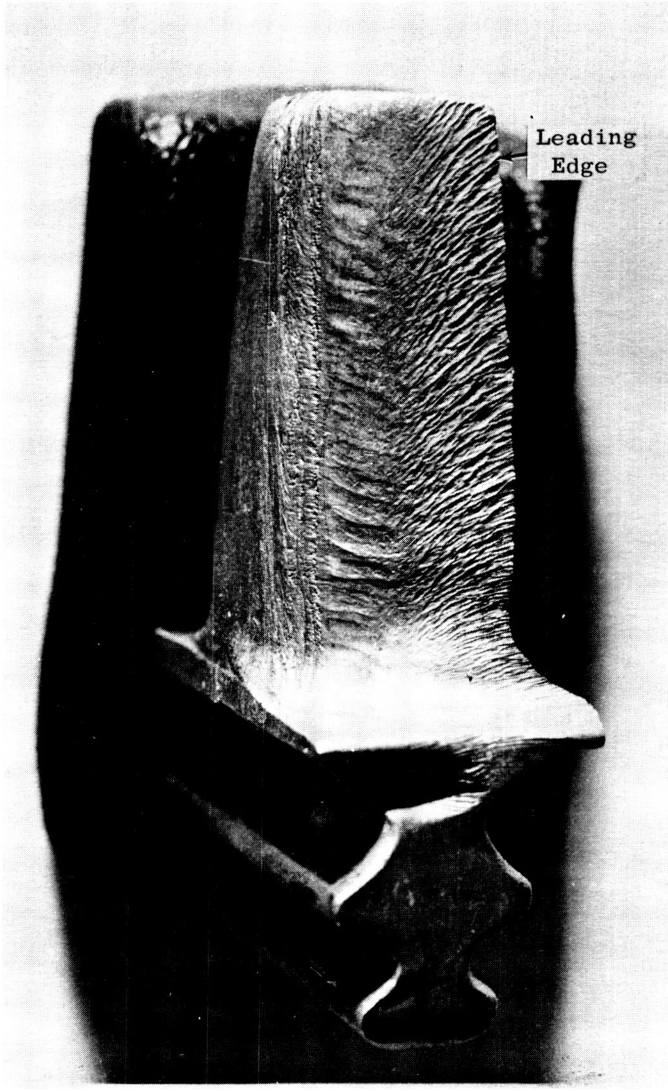


Figure 75. Stage 1 Turbine Rotor Blades.



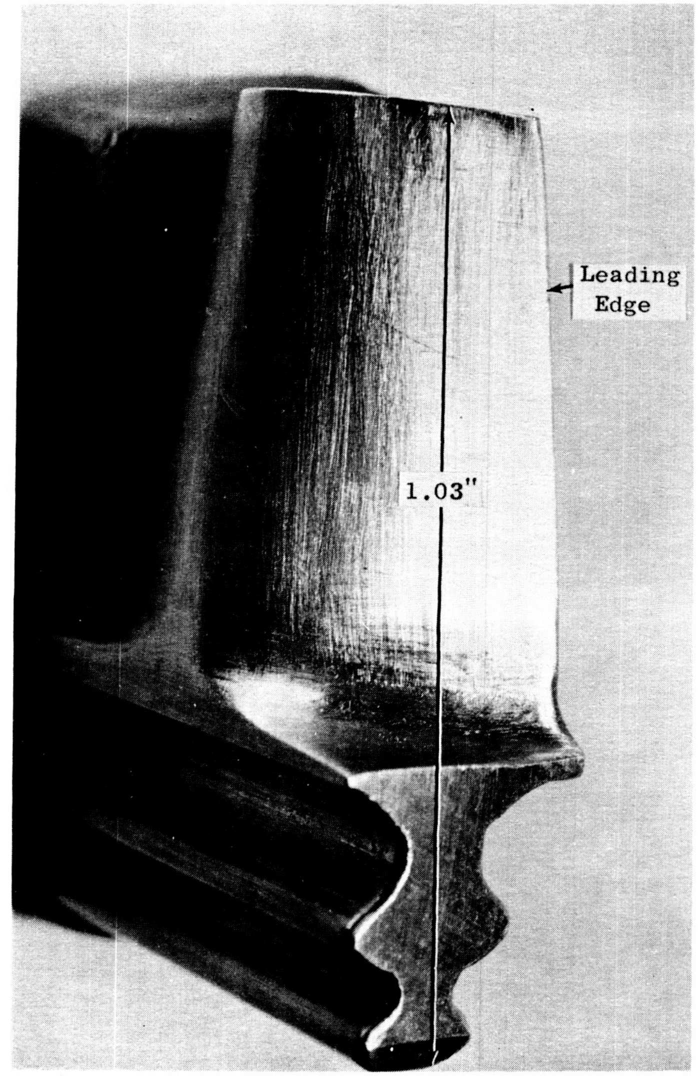


Figure 76. Comparison of New and Used Stage 1 Blade.

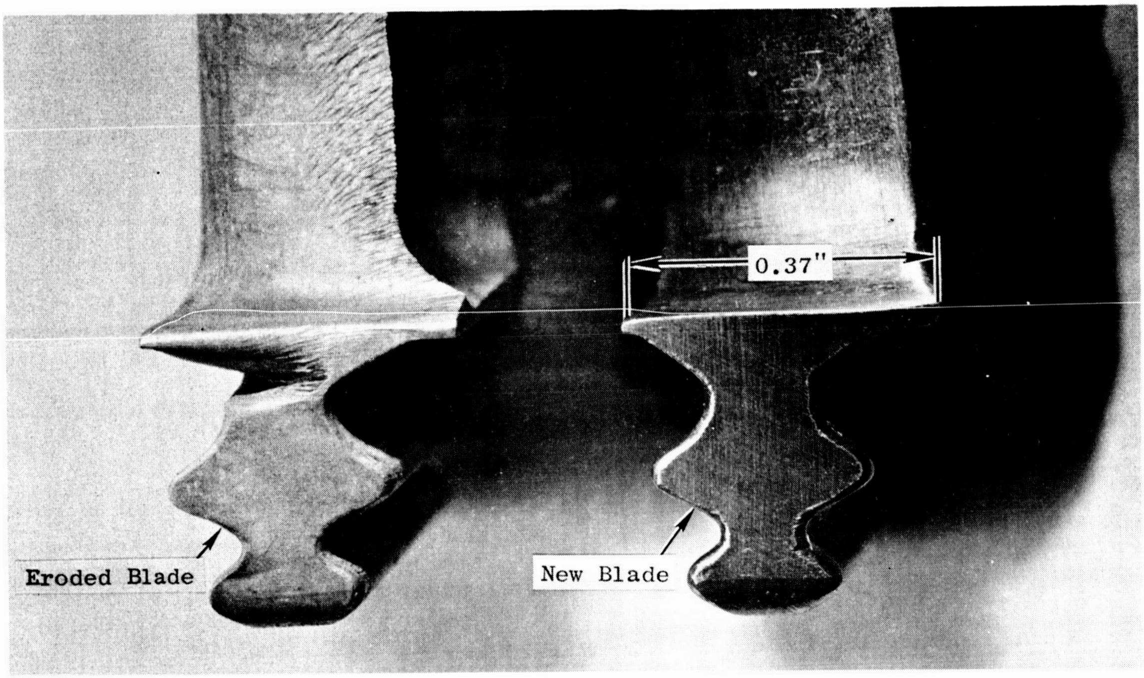


Figure 77. Comparison of Root-Region of New and Used Stage 1 Blade.

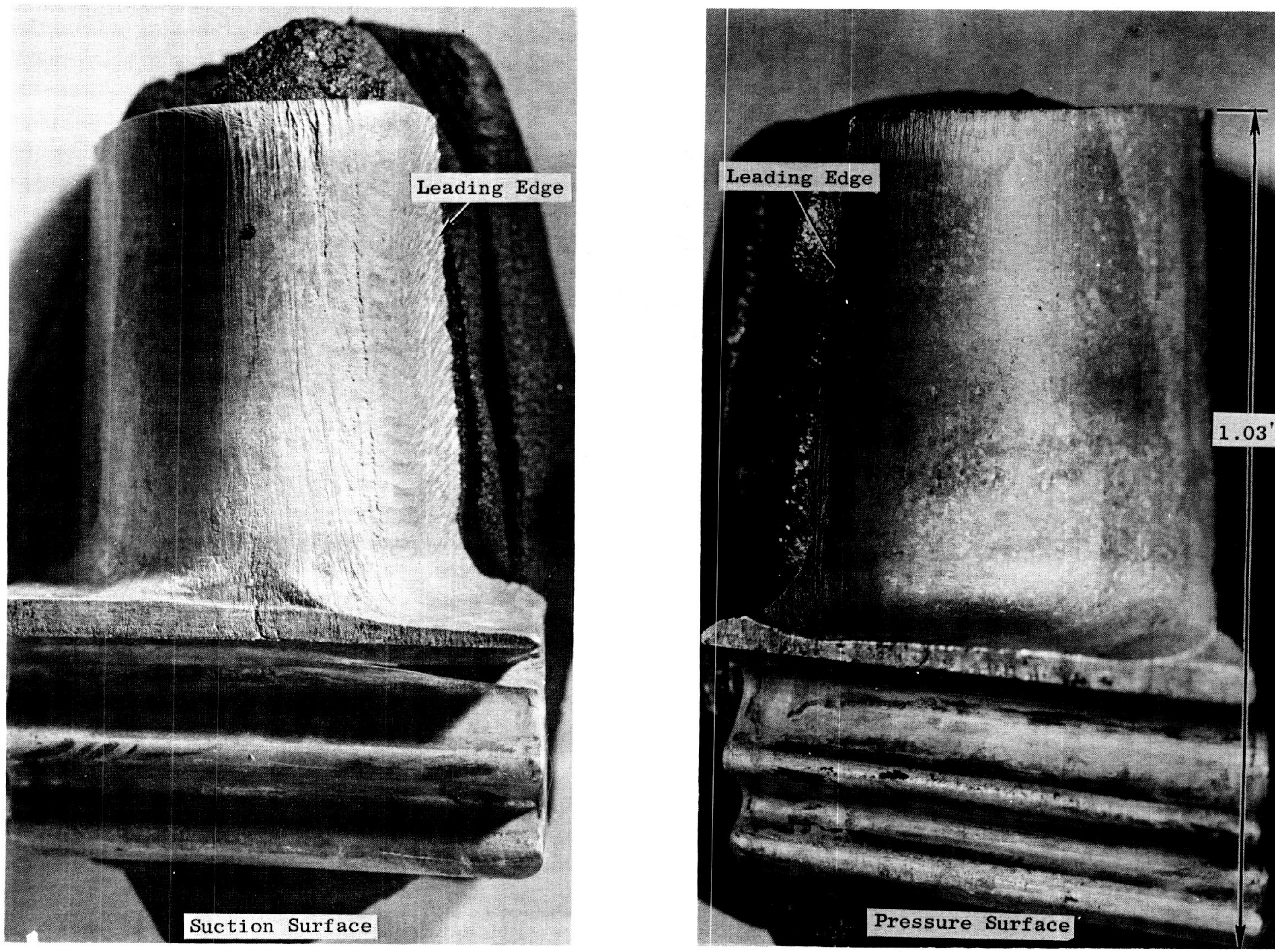


Figure 78. Suction and Pressure Surfaces of Stage 1 Blade.

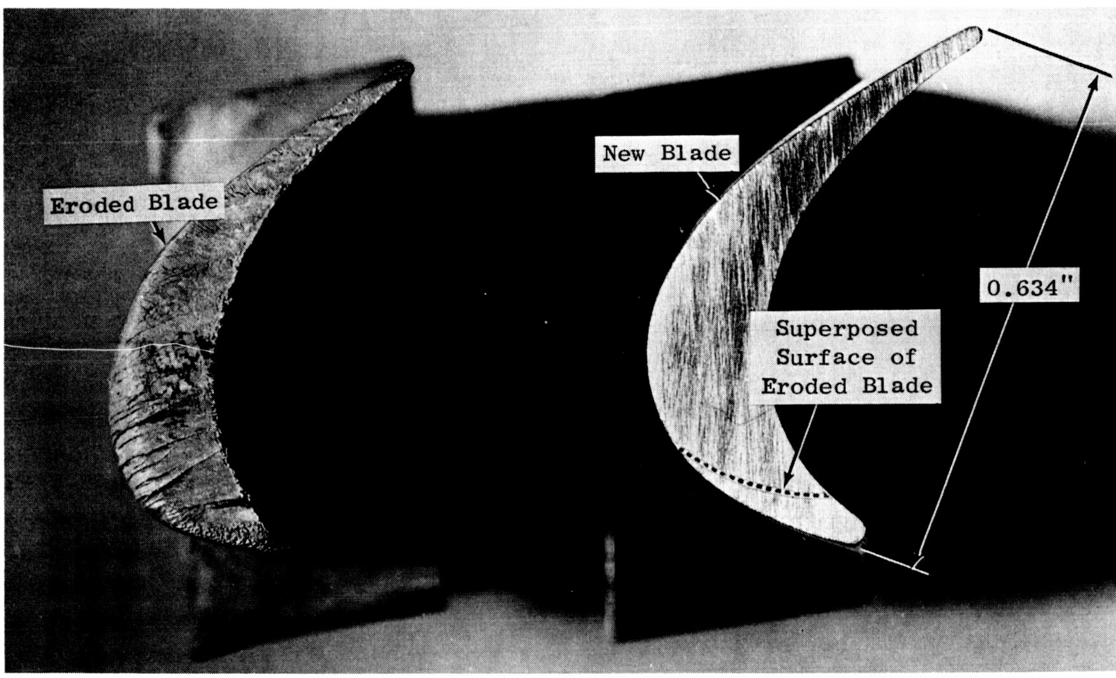


Figure 79. Comparison of Tip Section of New and Used Blade.

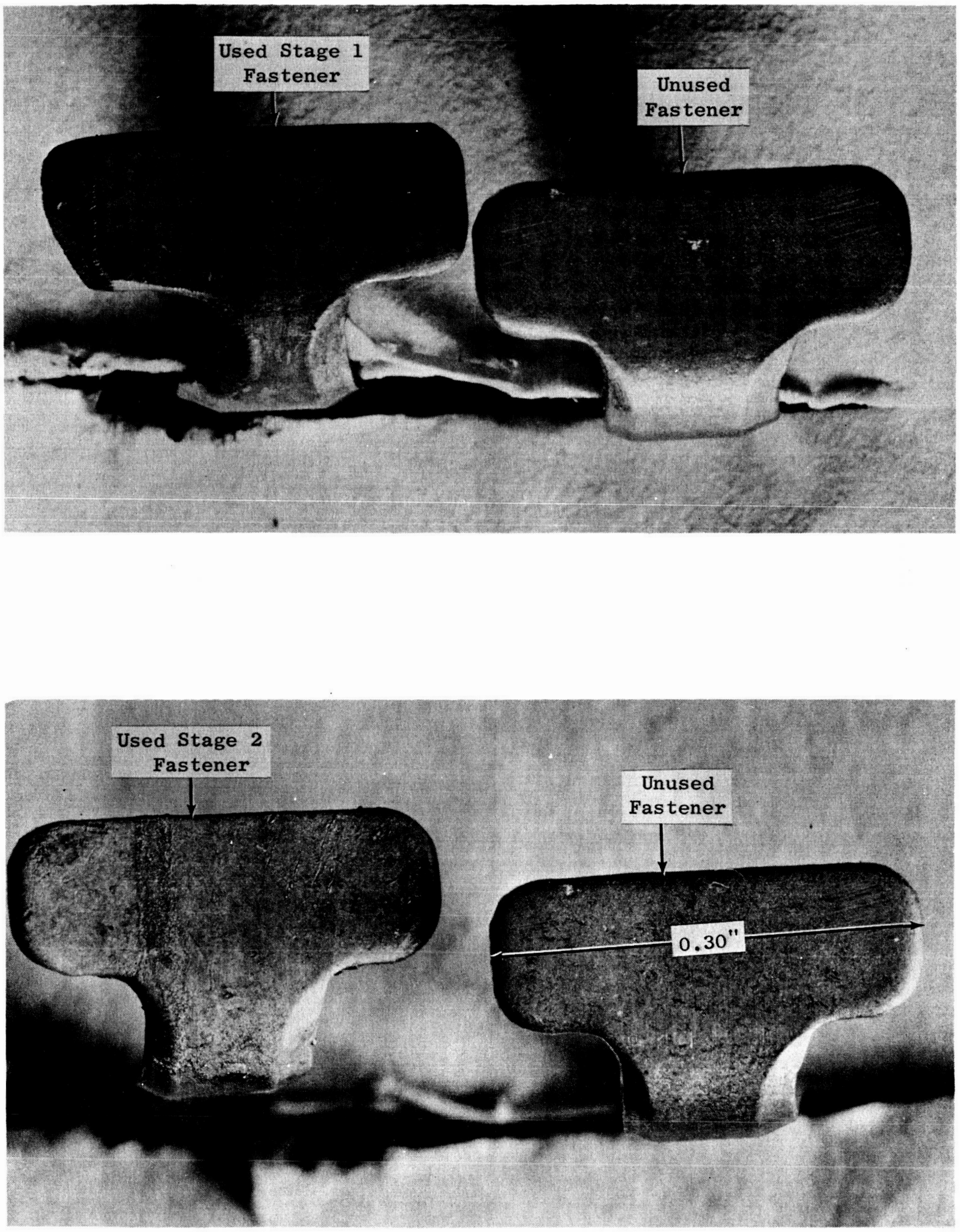


Figure 80. Comparison of New and Used Blade Fasteners.

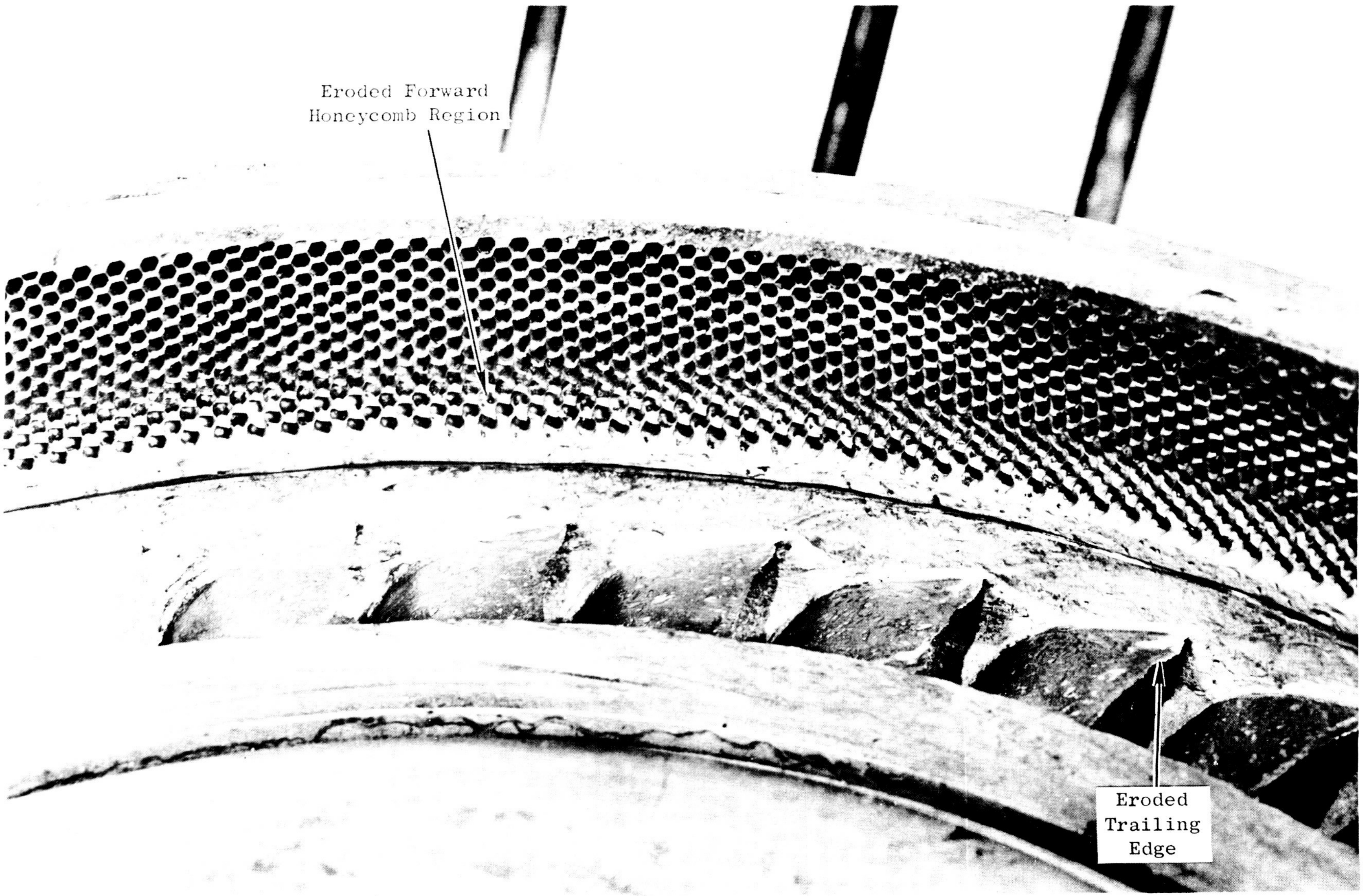


Figure 81. Stage 1 Honeycomb Tip Seal

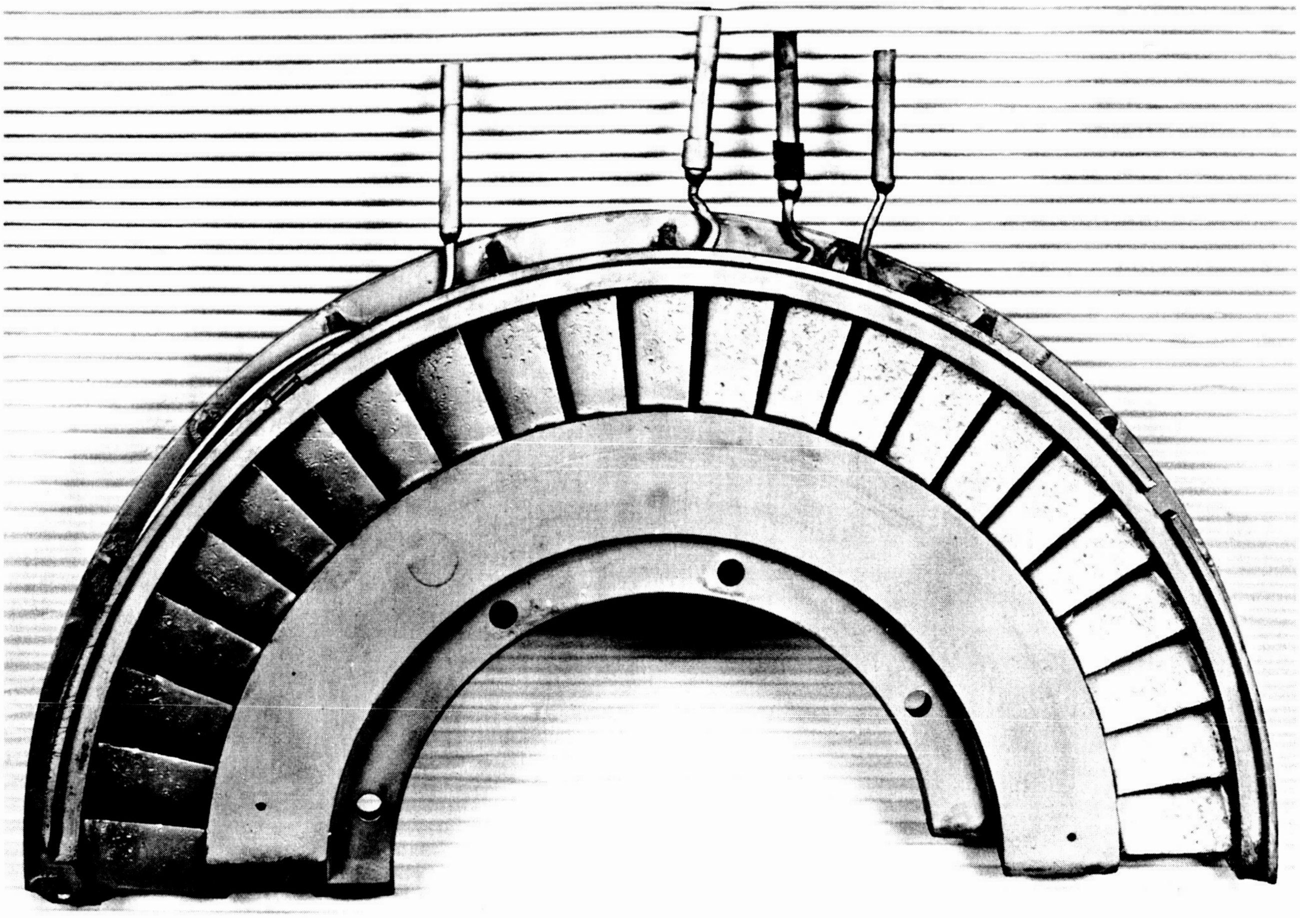


Figure 82. Second Stage Nozzle Diaphragm Upper Half

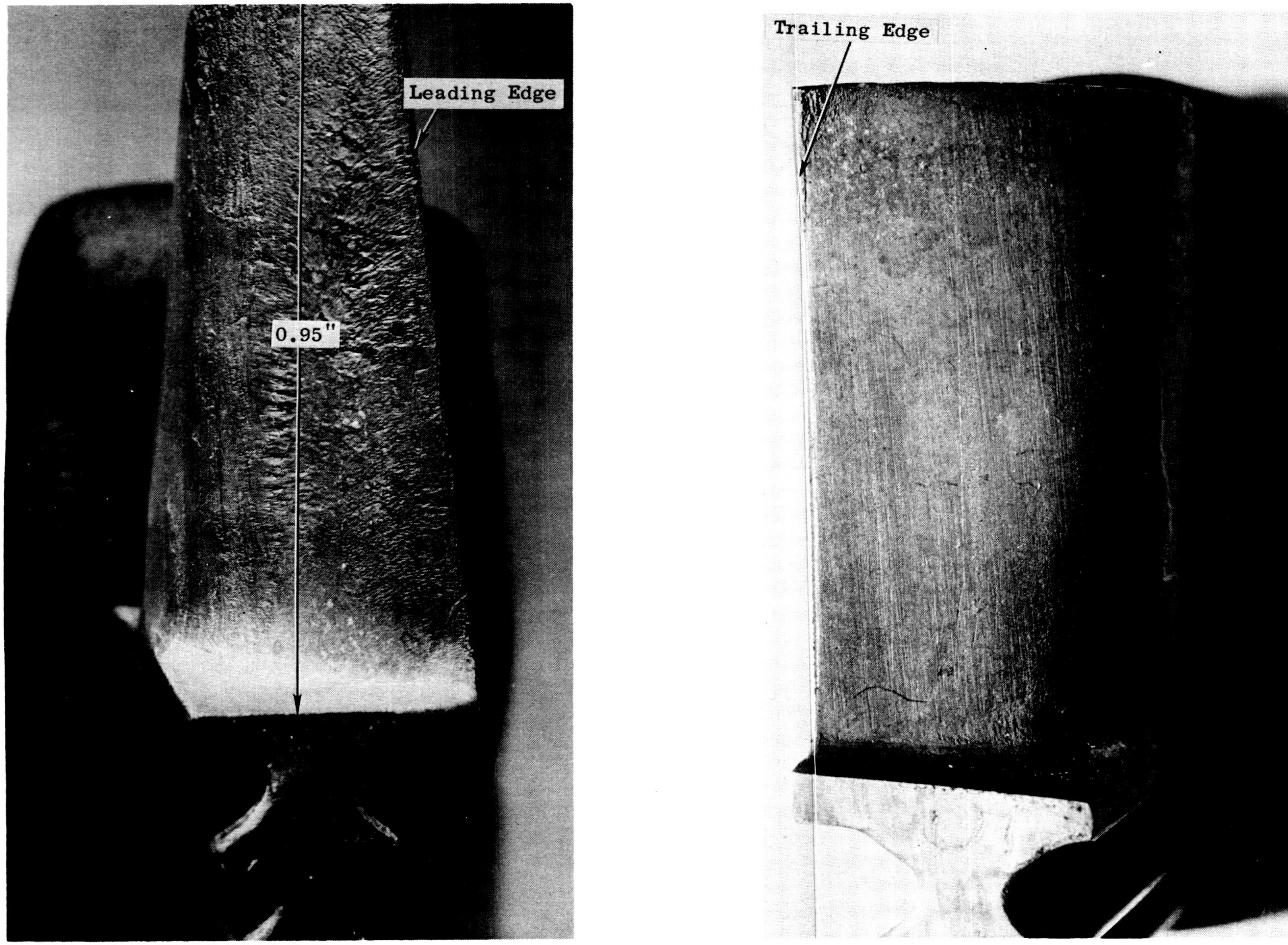


Figure 83. Leading and Trailing Edge of Stage 2 Blade.

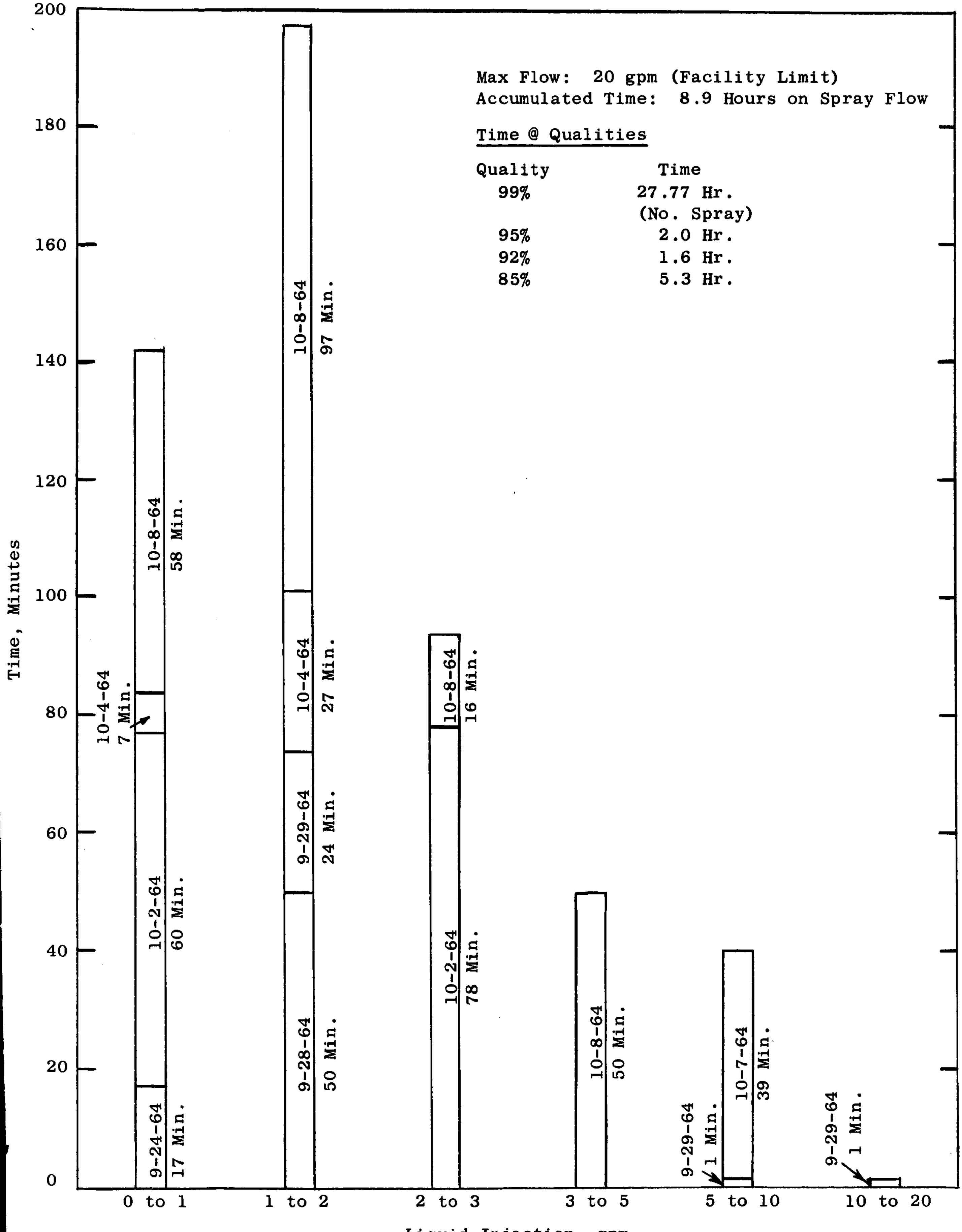


Figure 84. Time History of Potassium Liquid Injection into Turbine.

Figure 85. Stage 2 Nozzle Diaphragm Outer Shroud Fire Damage and Subsequent Repair.

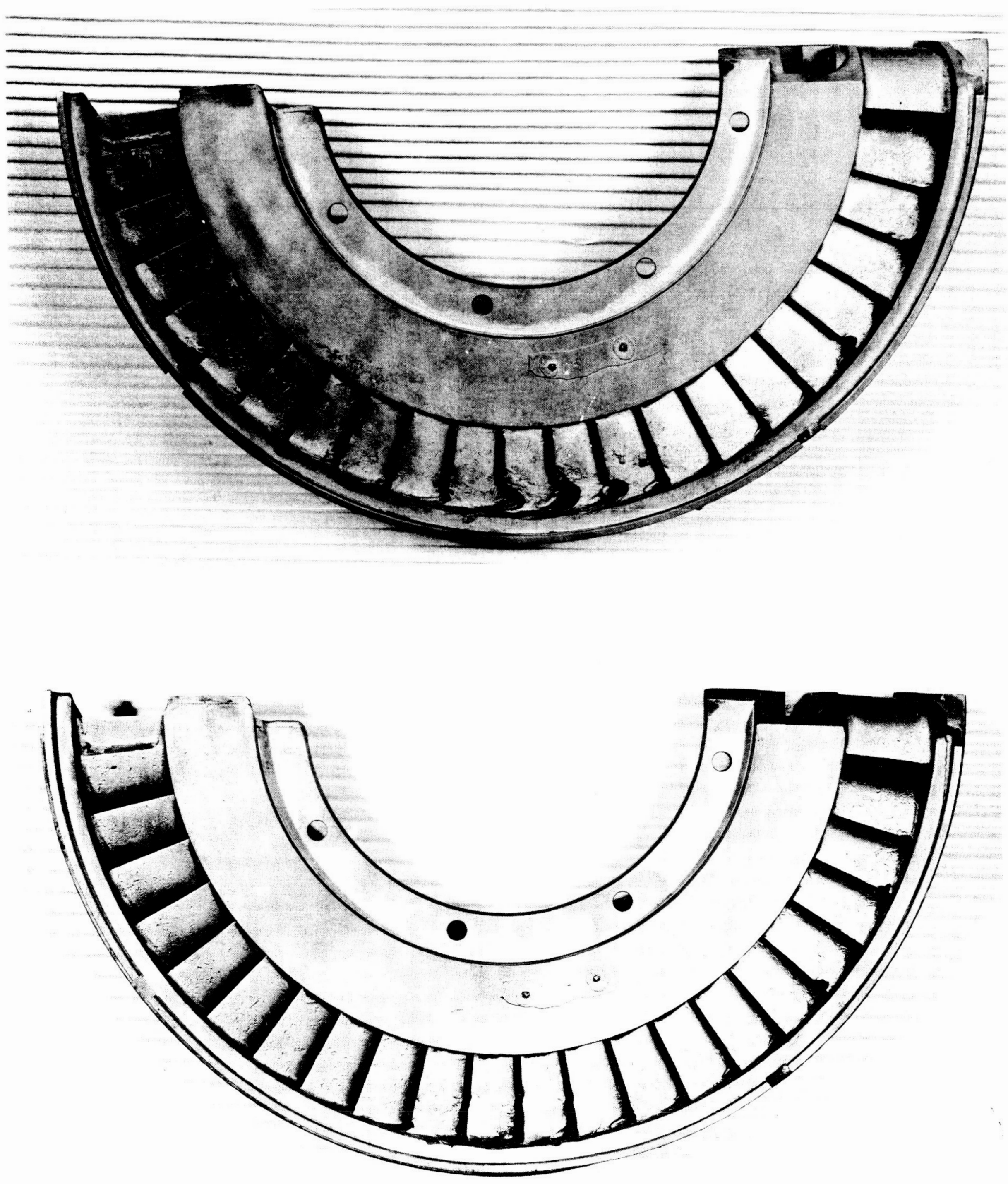


Figure 86. Stage 2 Nozzle Vane Fire Damage and Subsequent Repair.

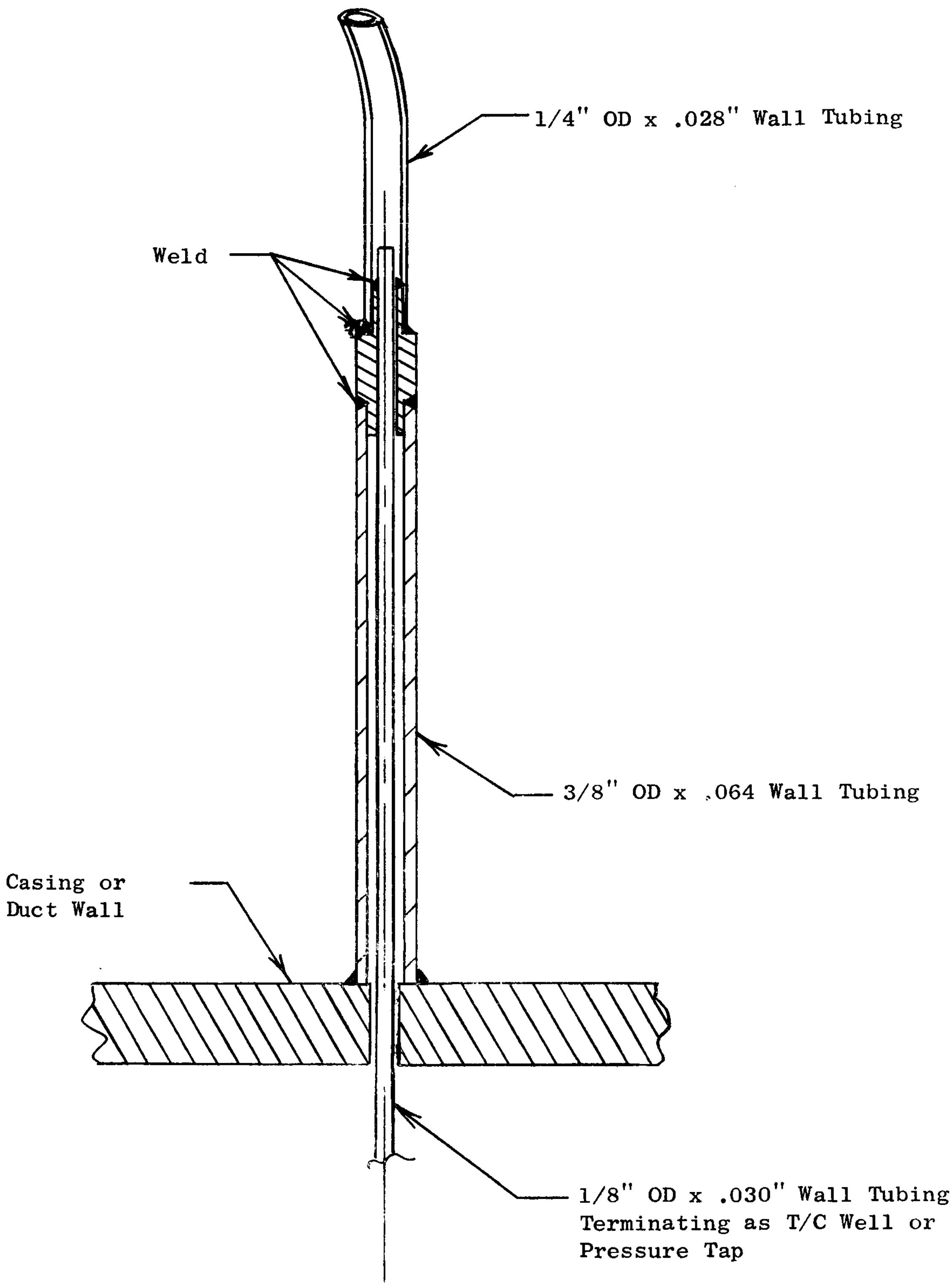


Figure 87 Construction of Instrumentation Extending from Turbine.

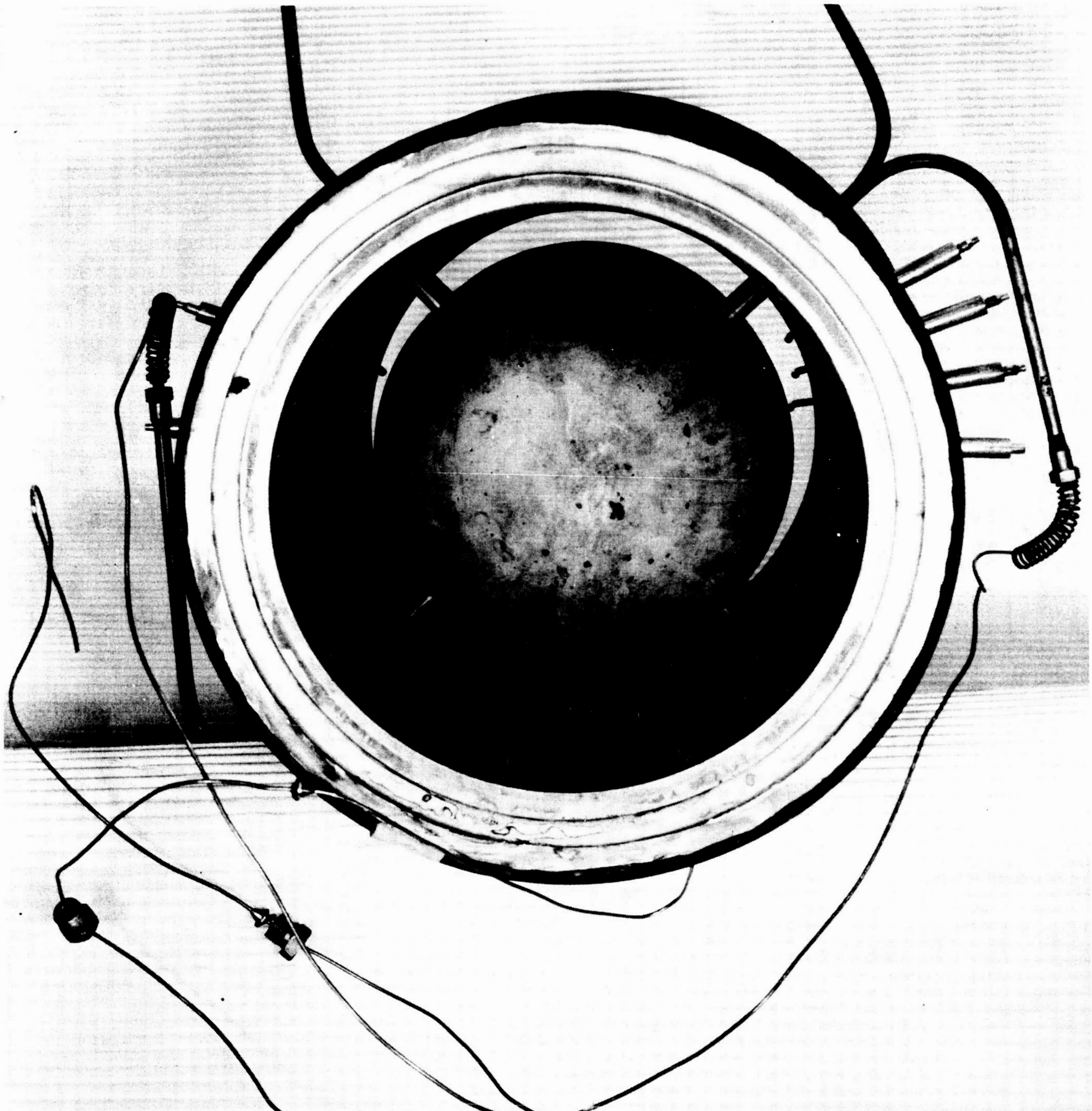


Figure 88. Newly Installed Pressure Probes at Station #3.

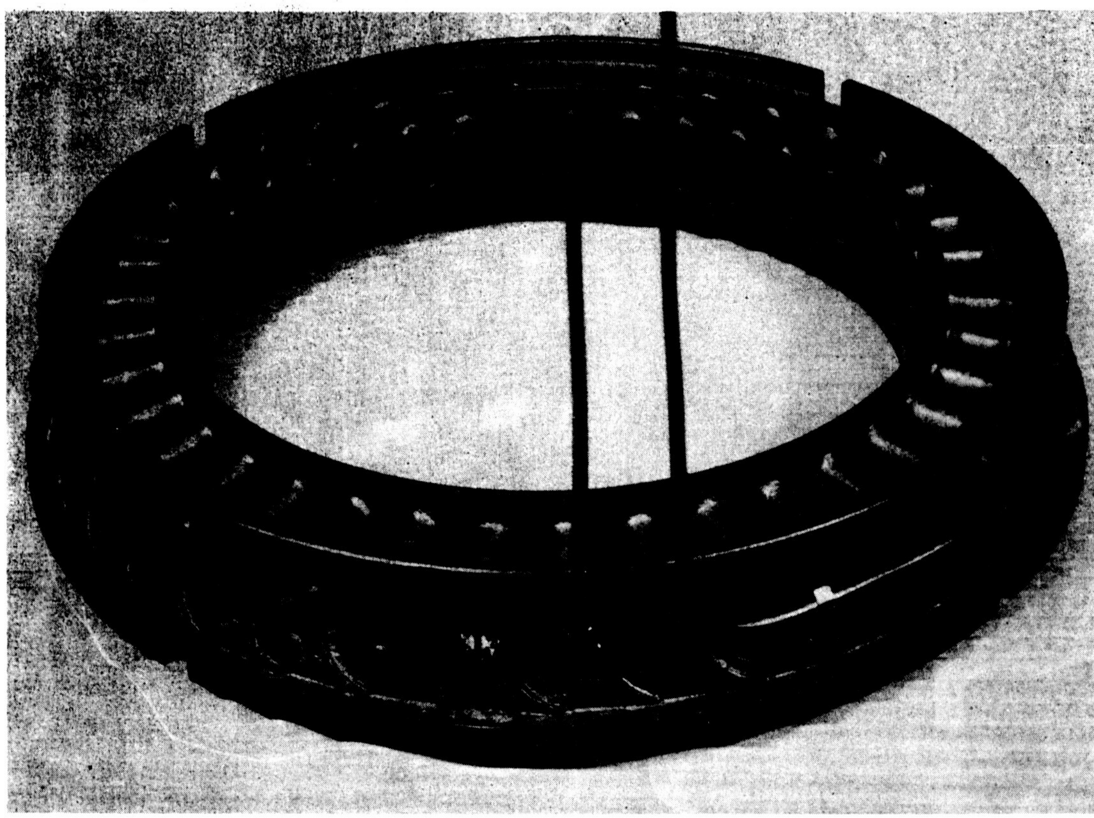


Figure 89. Re-Instrumentation of Turbine Inlet Nozzle Diaphragm.

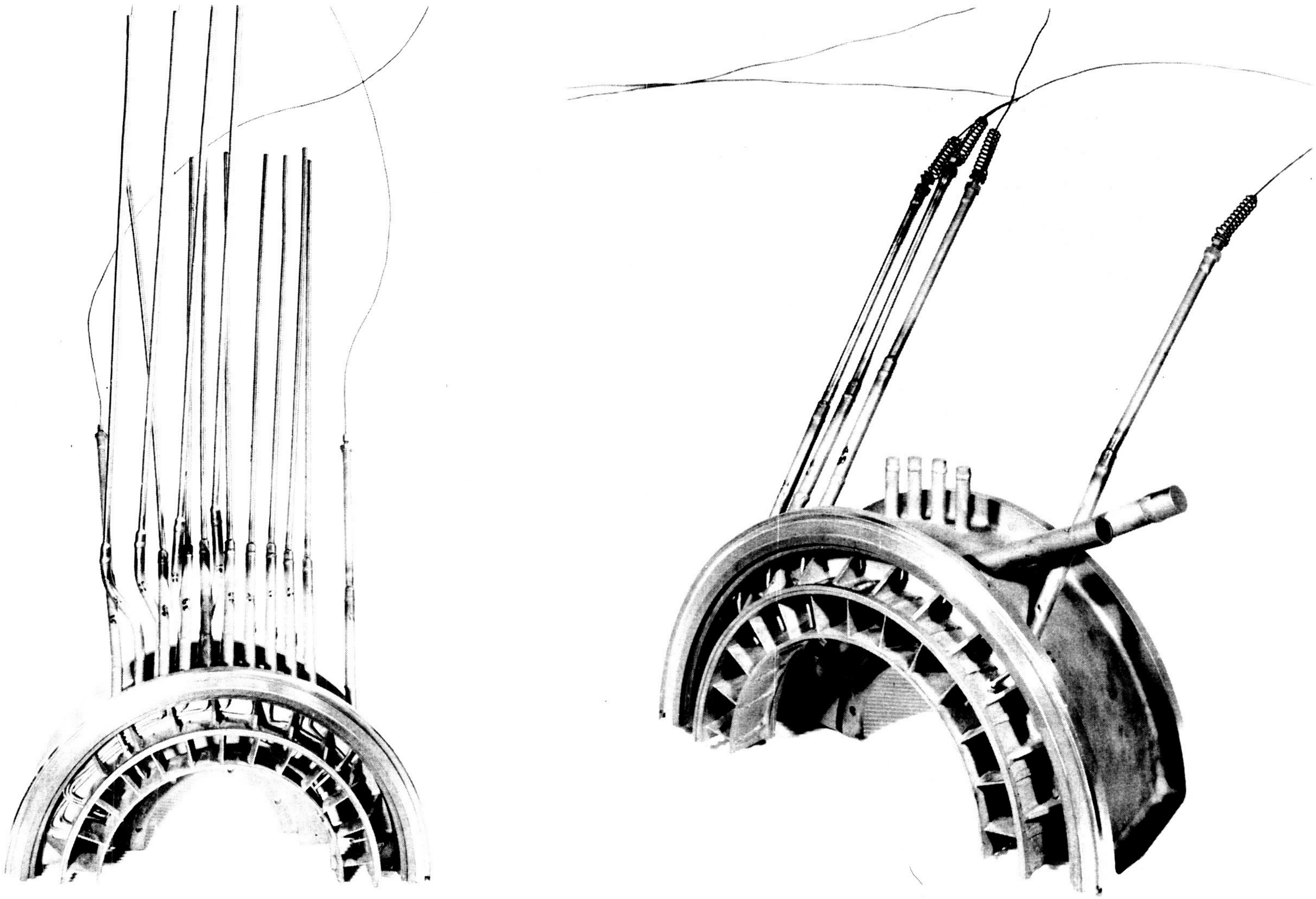


Figure 90. Re-instrumented Turbine Casing Prior to Final Assembly.

Figure 91. Bearing Housing Following Installation of Bellows Tube Cover

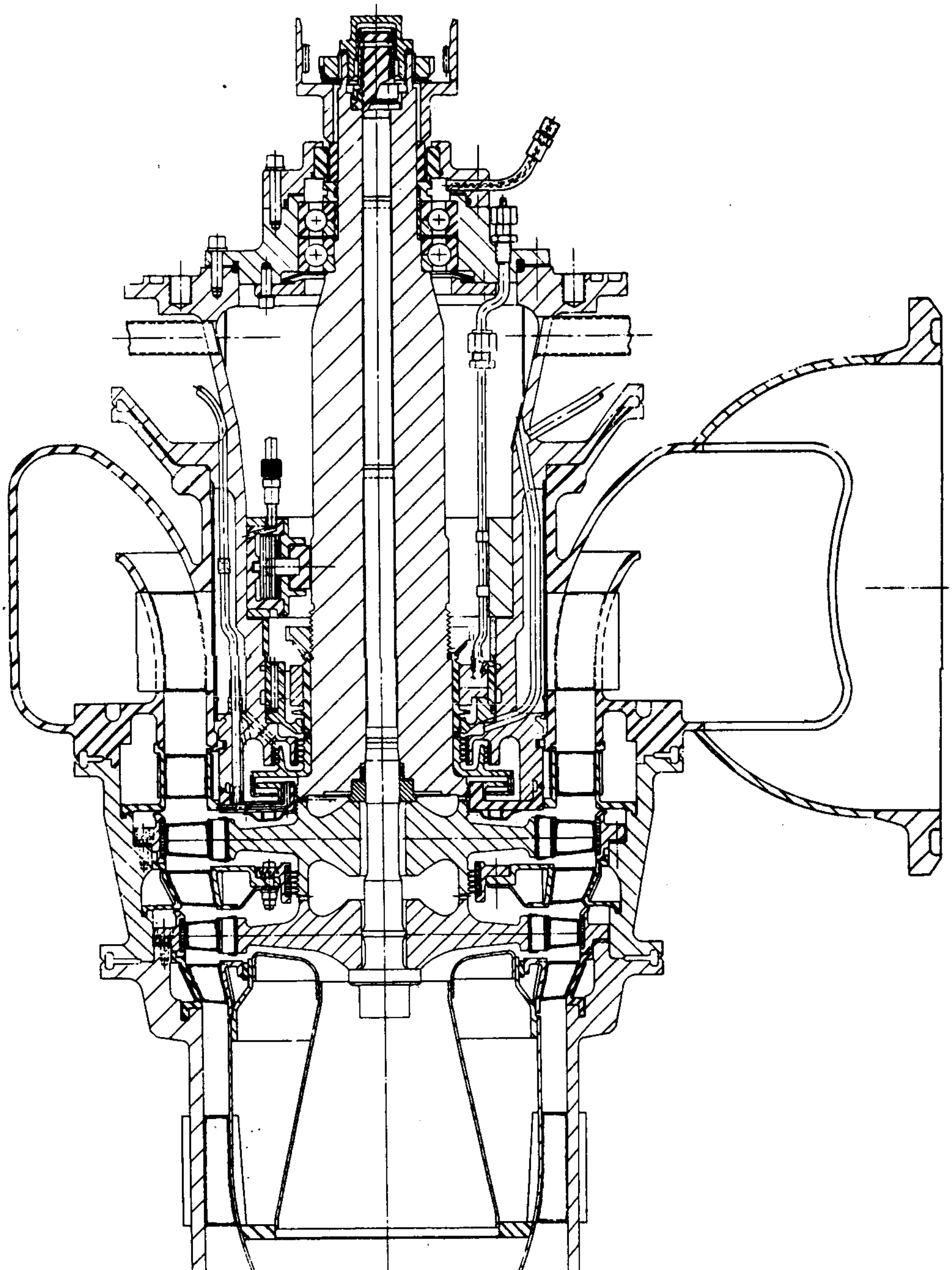
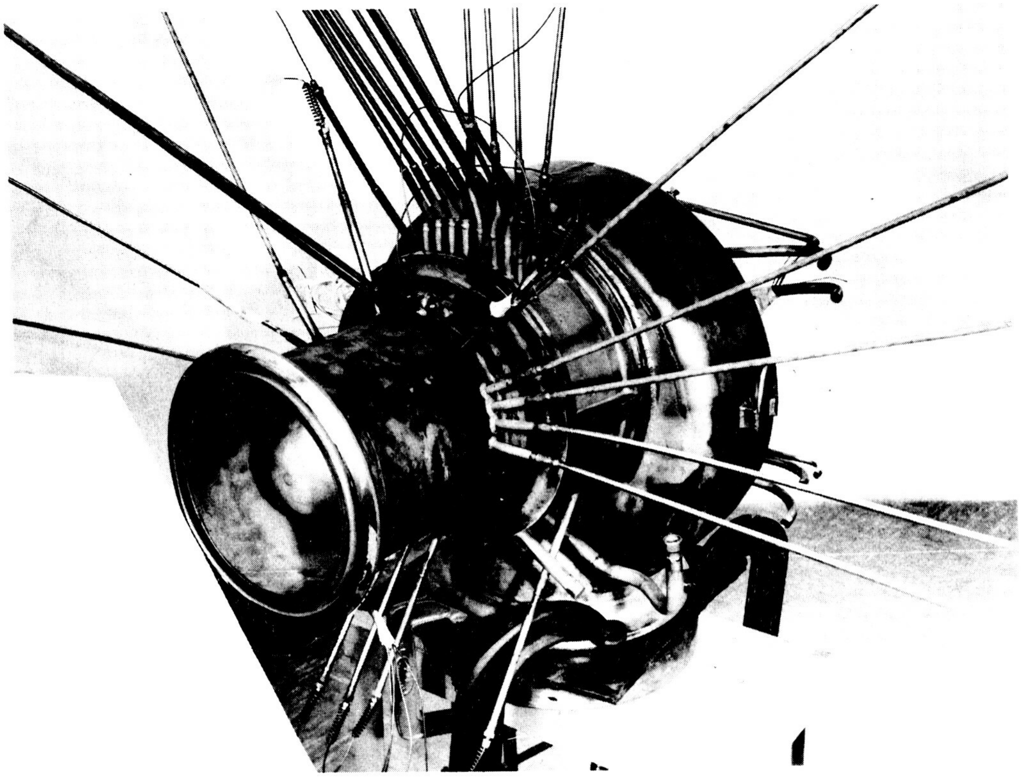


Figure 92. Potassium Test Turbine Assembly Drawing



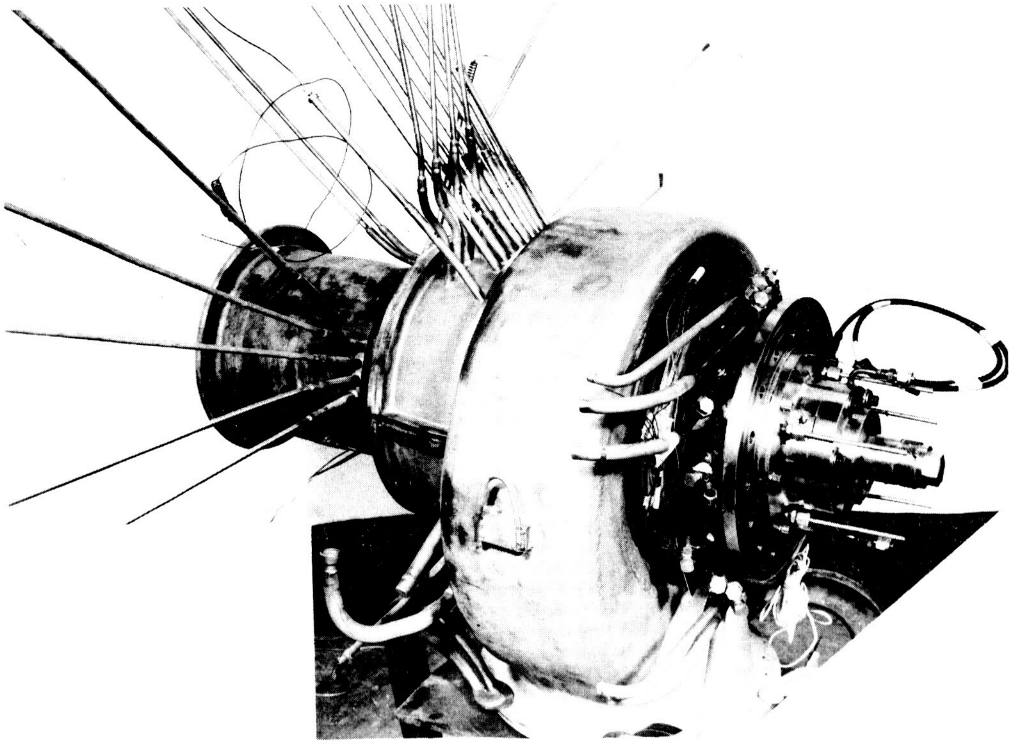


Figure 93. Turbine Ready for Installation into Test Facility.

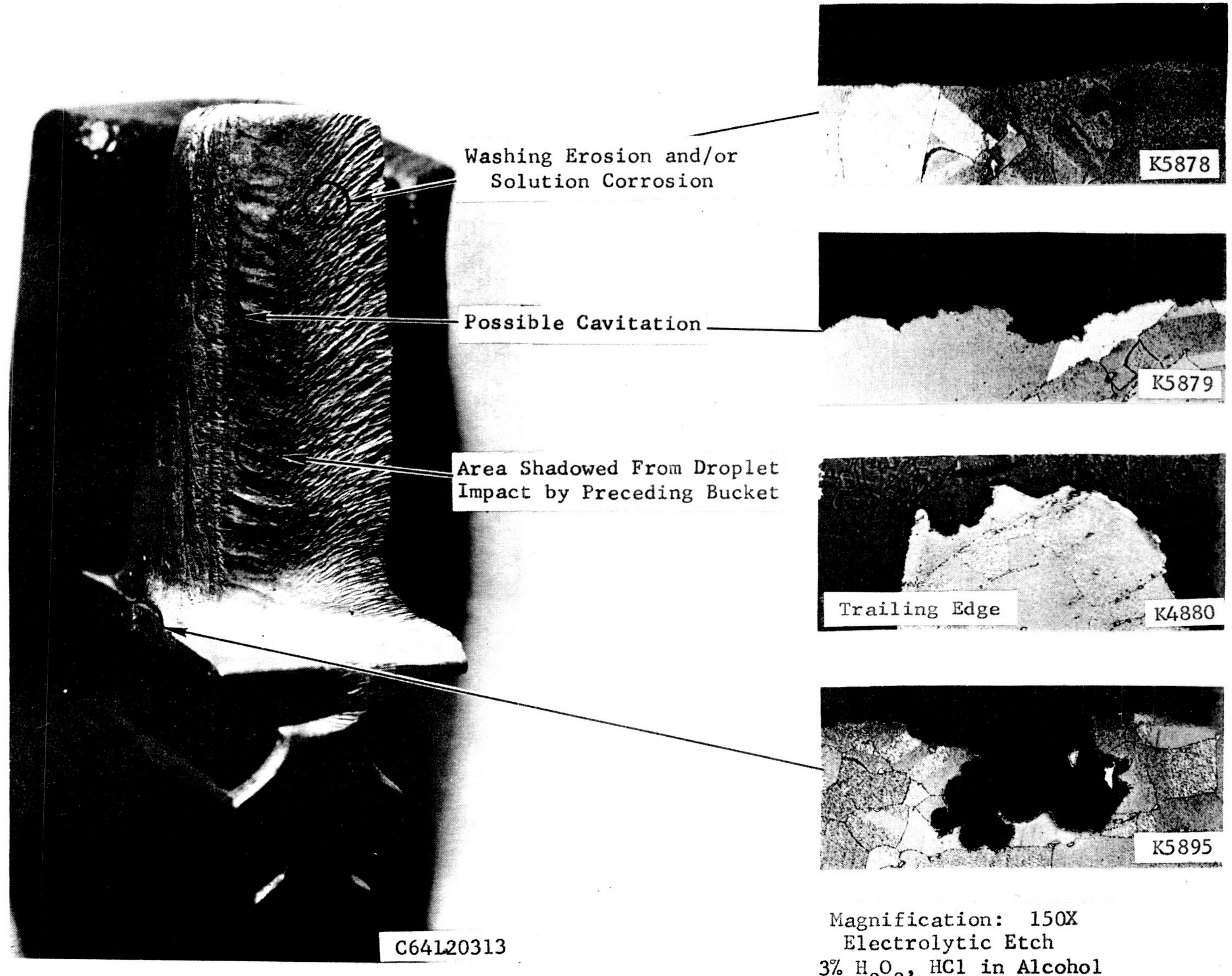


Figure 94. Photomicrographs Showing Nature of Metal Removal From Surface of First Stage Turbine Bucket.

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